US005296894A

United States Patent [19]

Green et al.

[11] Patent Number: 5,296,894

[45] Date of Patent: Mar. 22, 1994

[54] **IMAGE FORMING APPARATUS AND AN IMAGE MEMBER CARTRIDGE CONTAINING A PHOTOCONDUCTIVE DRUM**

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[73] Assignee: **Eastman Kodak Company**, Rochester, N.Y.

[21] Appl. No.: **985,075**

[22] Filed: **Dec. 3, 1992**

[51] **Int. Cl.**[5] **G03G 15/00**

[52] **U.S. Cl.** **355/200**; 355/210; 355/299

[58] **Field of Search** 355/200, 203, 208, 210, 355/211, 260, 296, 299, 298; 15/256.5; 346/108, 153.1, 160.1

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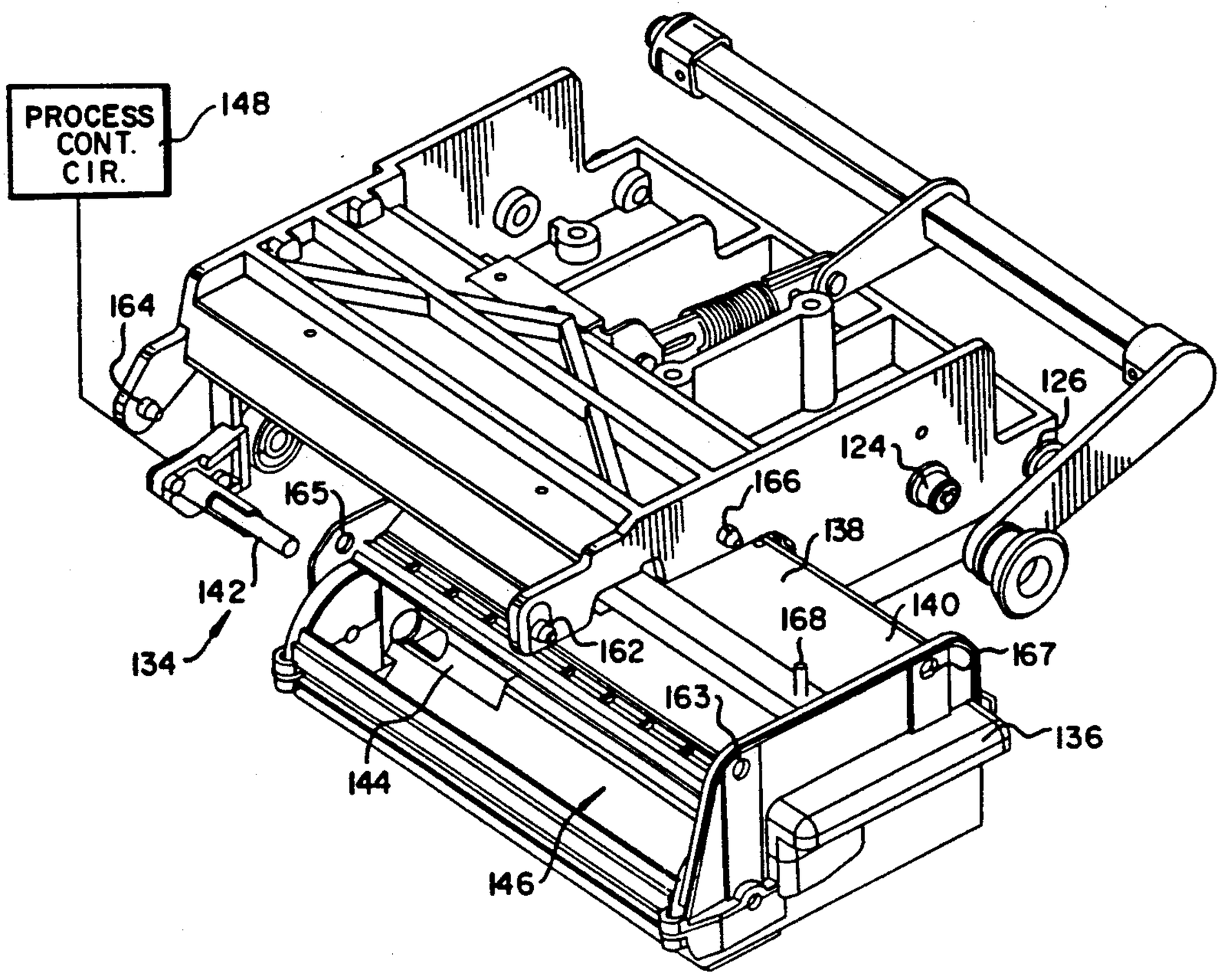
Primary Examiner—A. T. Grimley
Assistant Examiner—William J. Royer
Attorney, Agent, or Firm—Leonard W. Treash, Jr.

[57] **ABSTRACT**

An image forming apparatus includes a nest for receiving a photoconductive drum cartridge. The nest includes an electrometer projecting from an end of the nest parallel to an axis of rotation of a drum in a received cartridge. An opening in a received cartridge housing receives the electrometer closely spaced from the photoconductive drum. The cartridge also includes a charging station and a cleaning station. The cleaning station includes a blade and a roller upstream of the blade for directing cleaned toner toward a containing device opposite the blade from the roller.

11 Claims, 24 Drawing Sheets



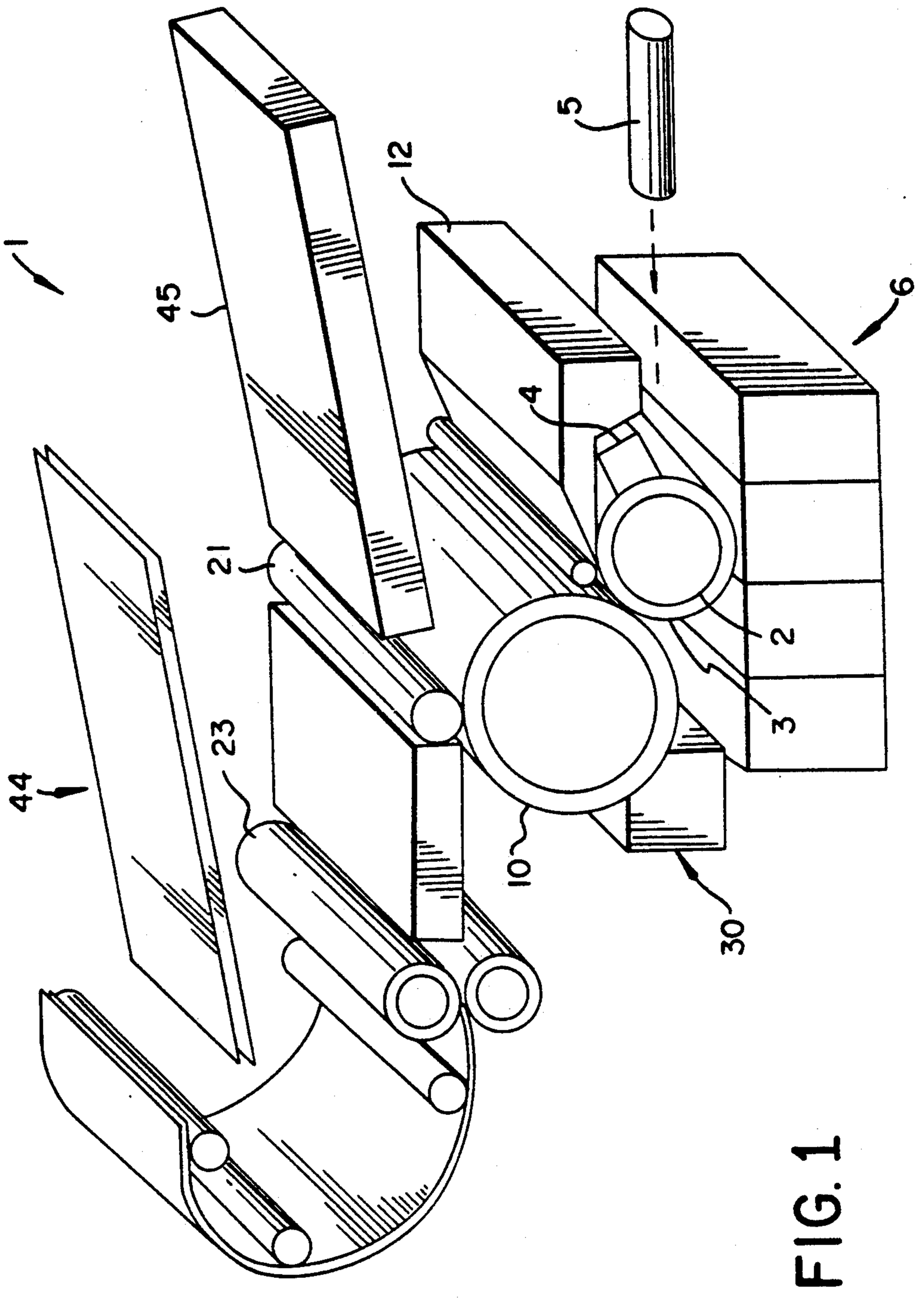


FIG. 1

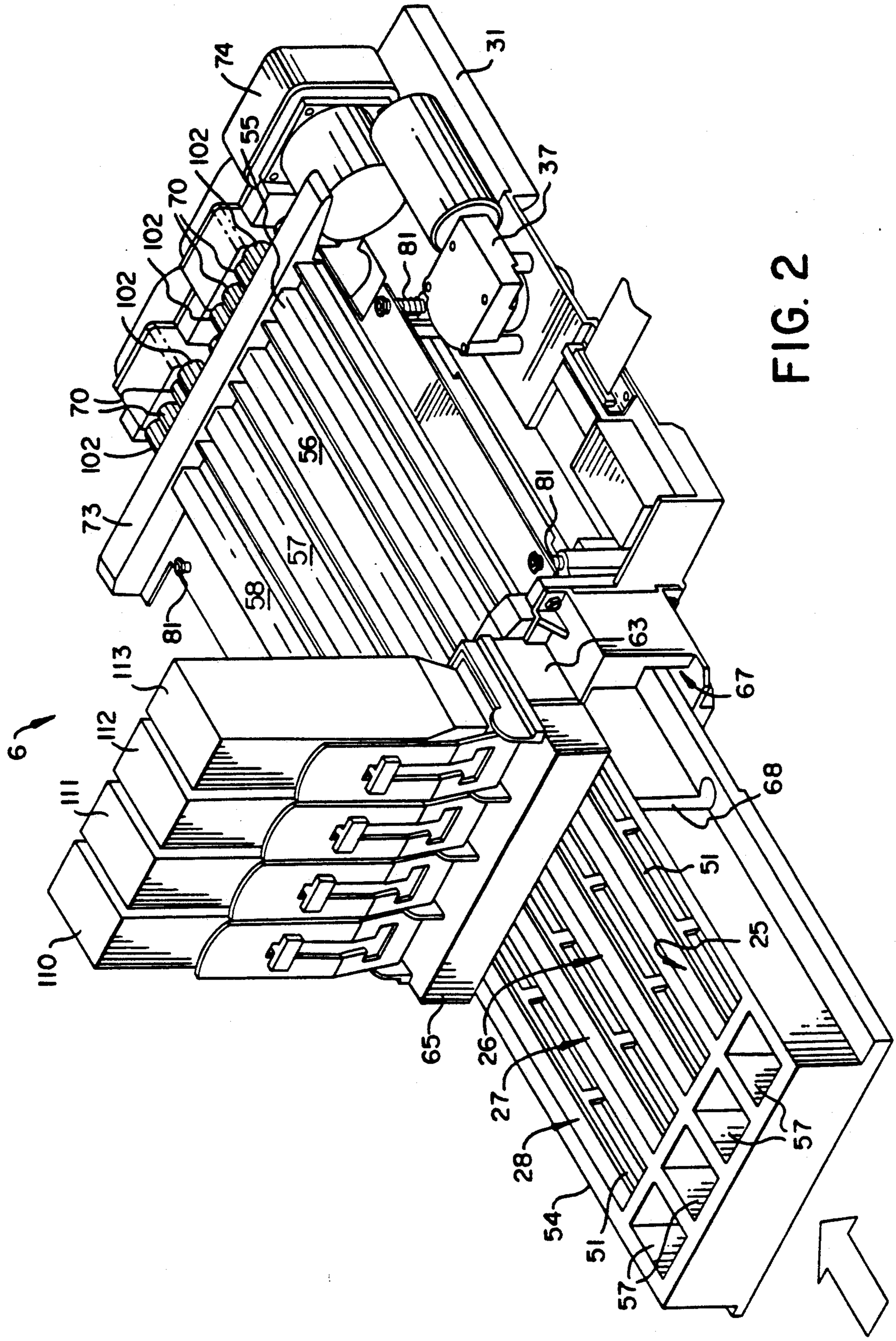

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FIG. 2

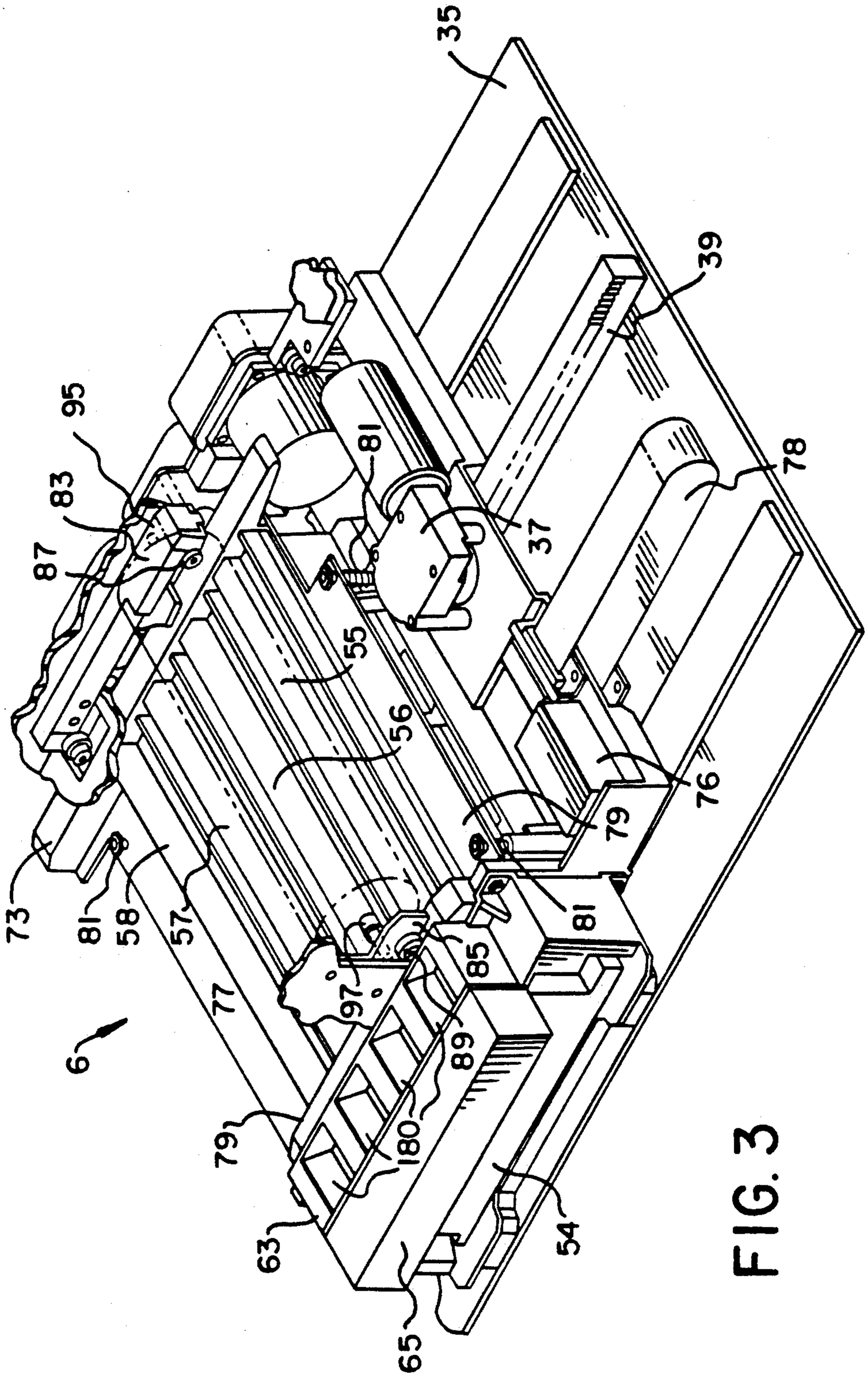
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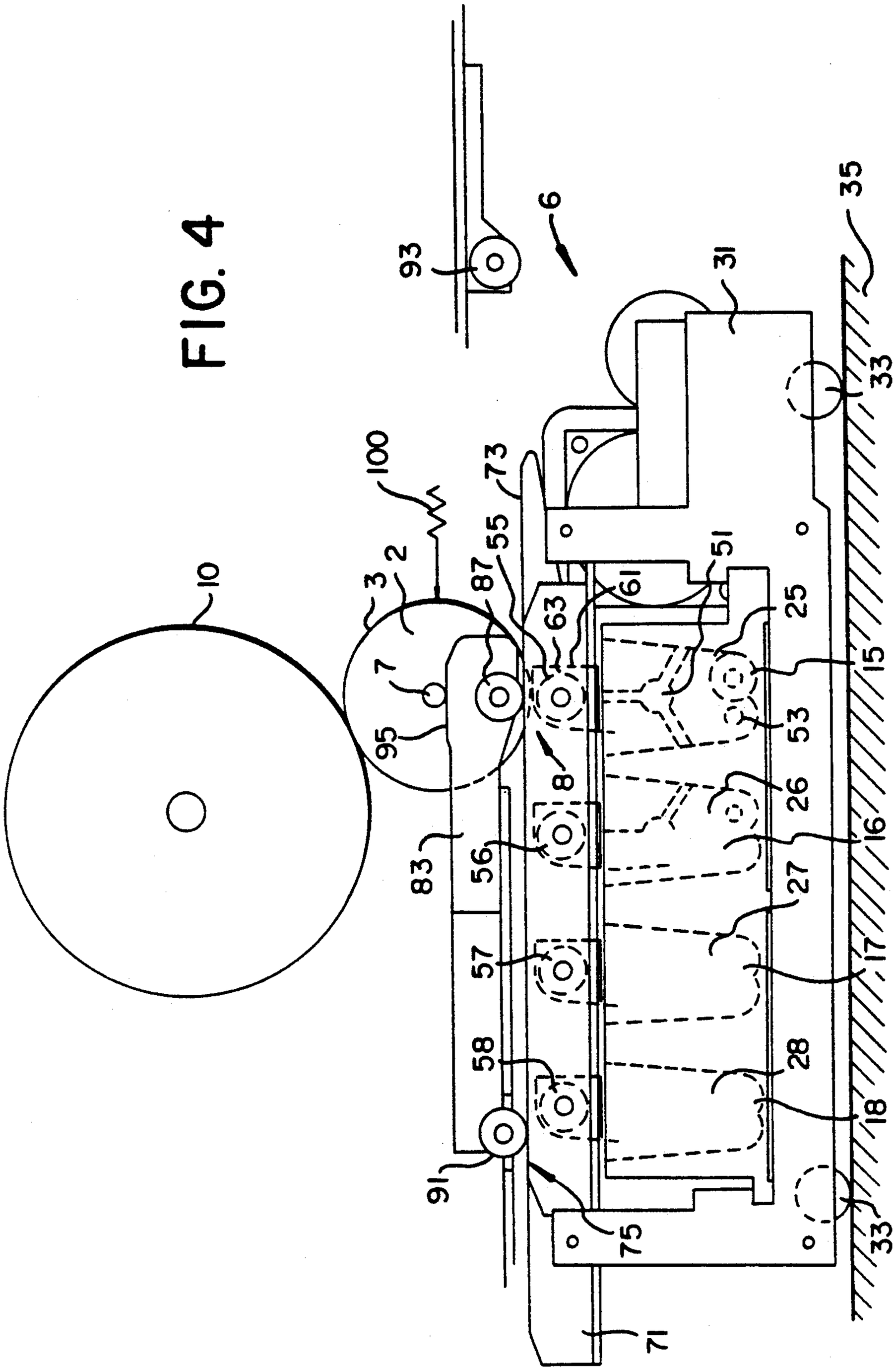
FIG. 3

FIG. 4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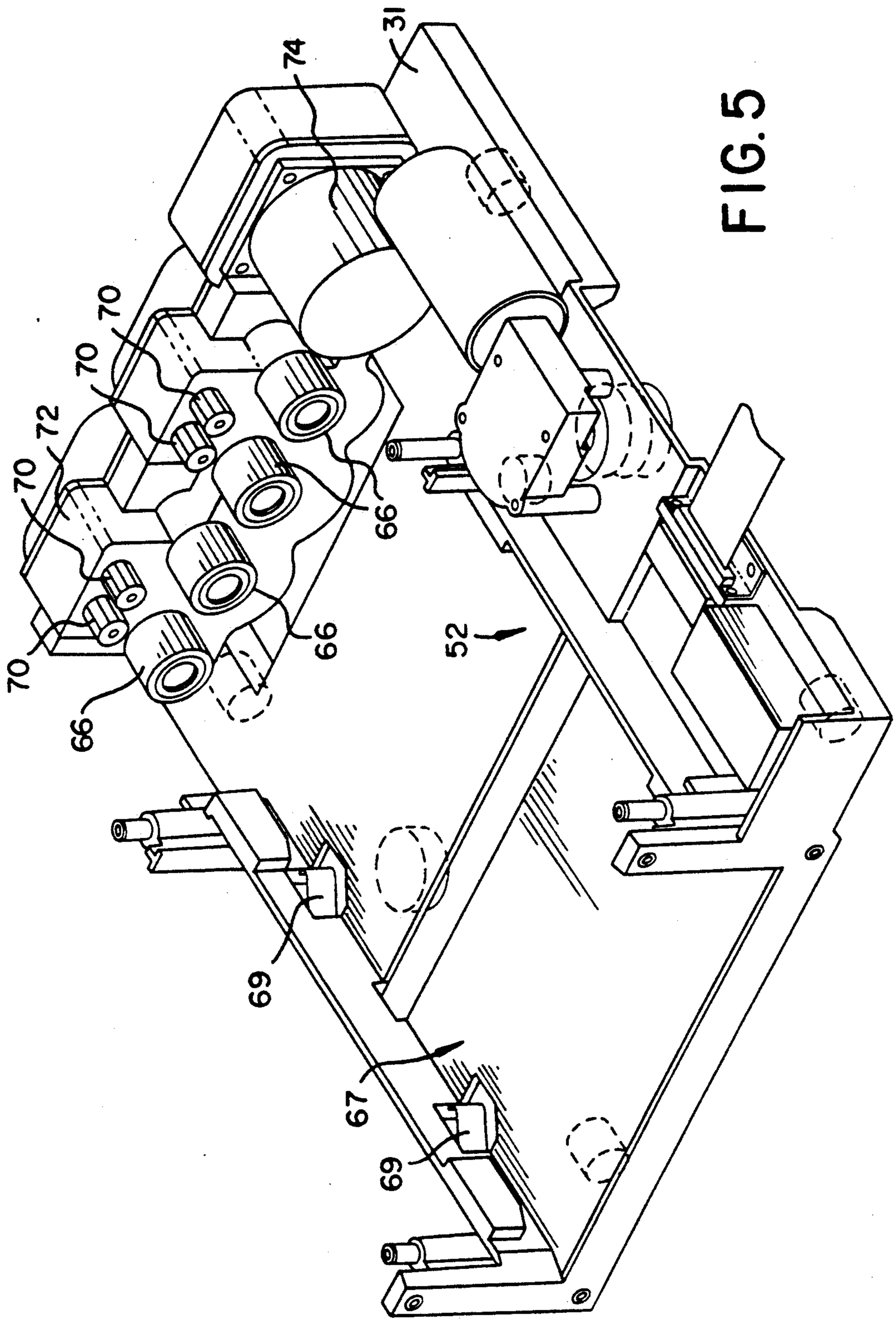
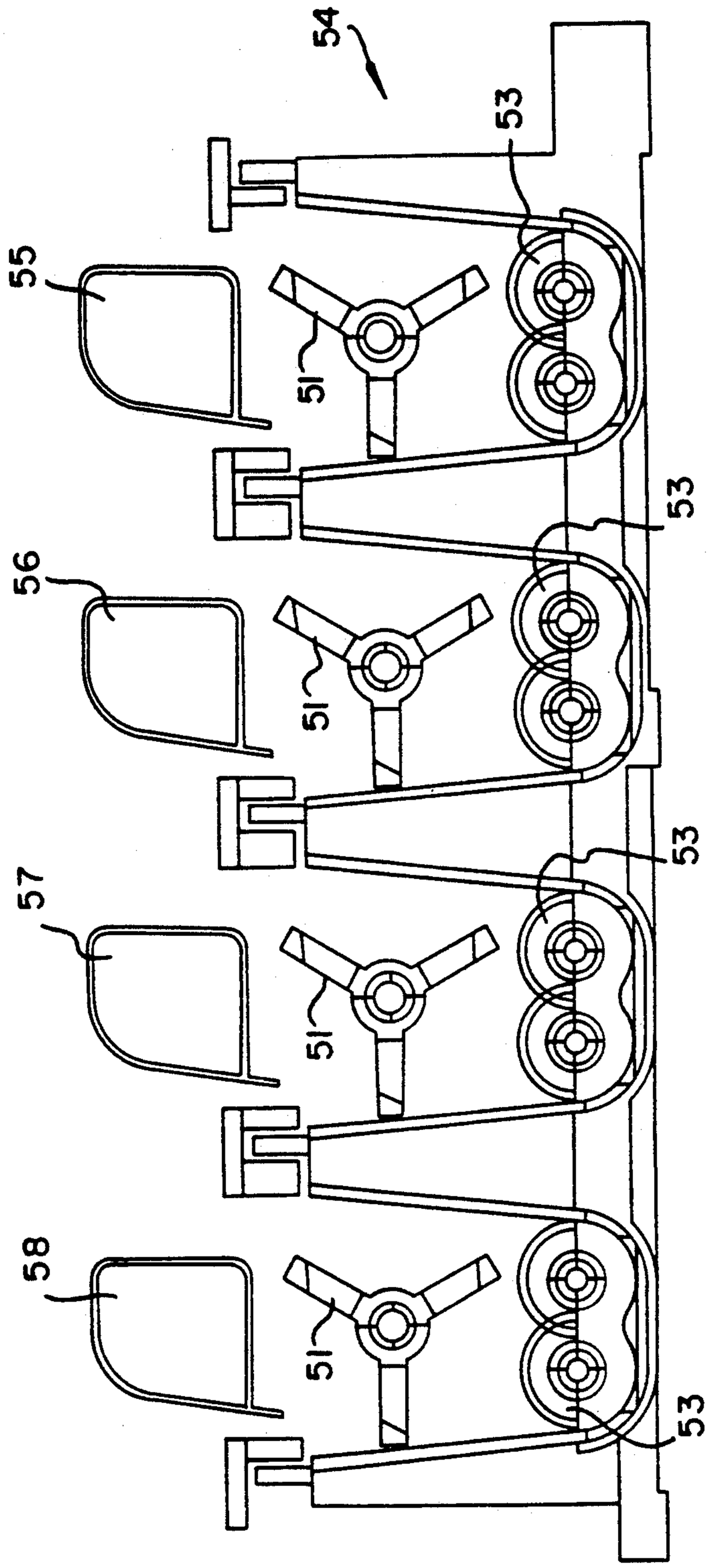


FIG. 5

FIG. 6



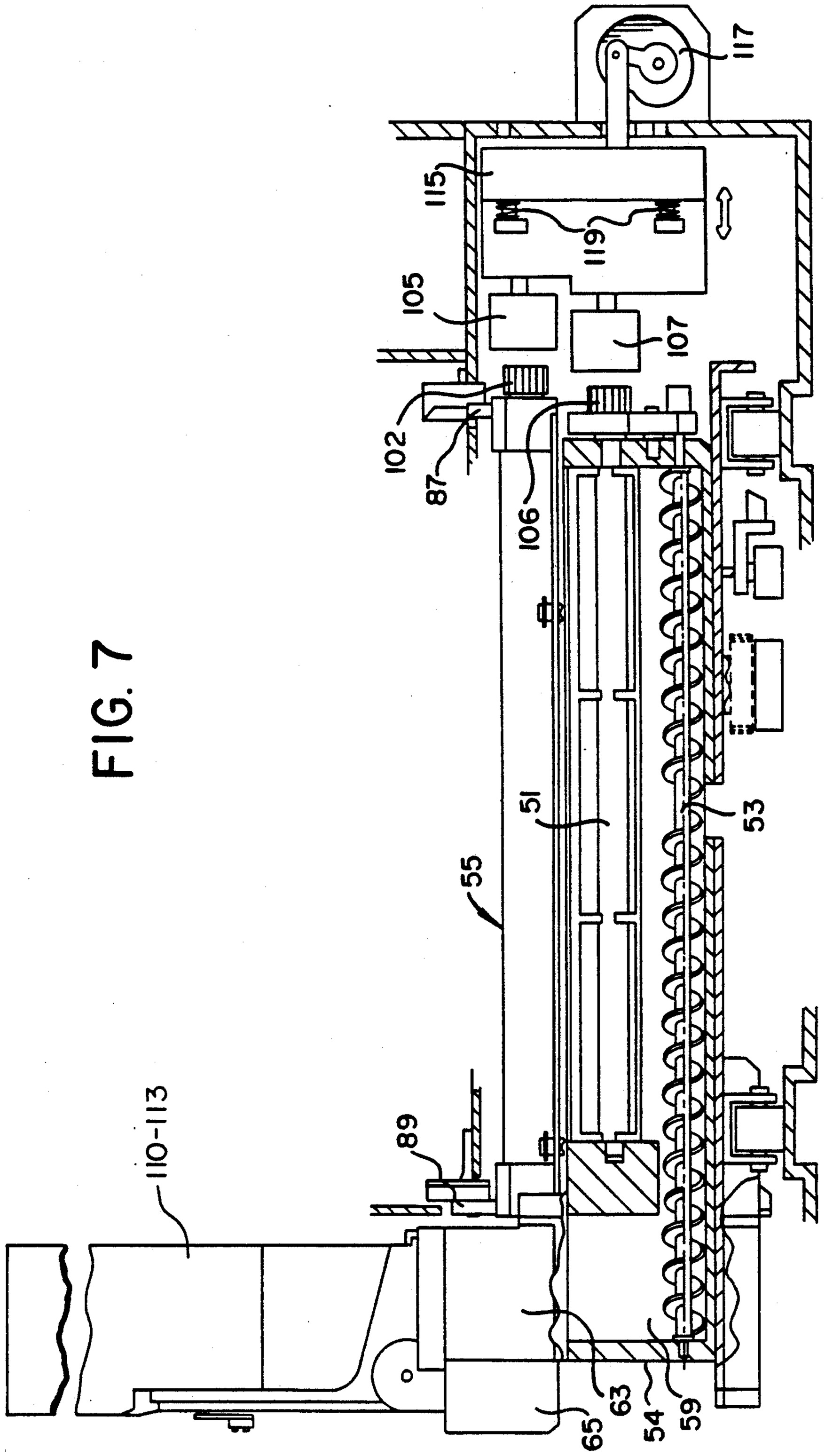


FIG. 7

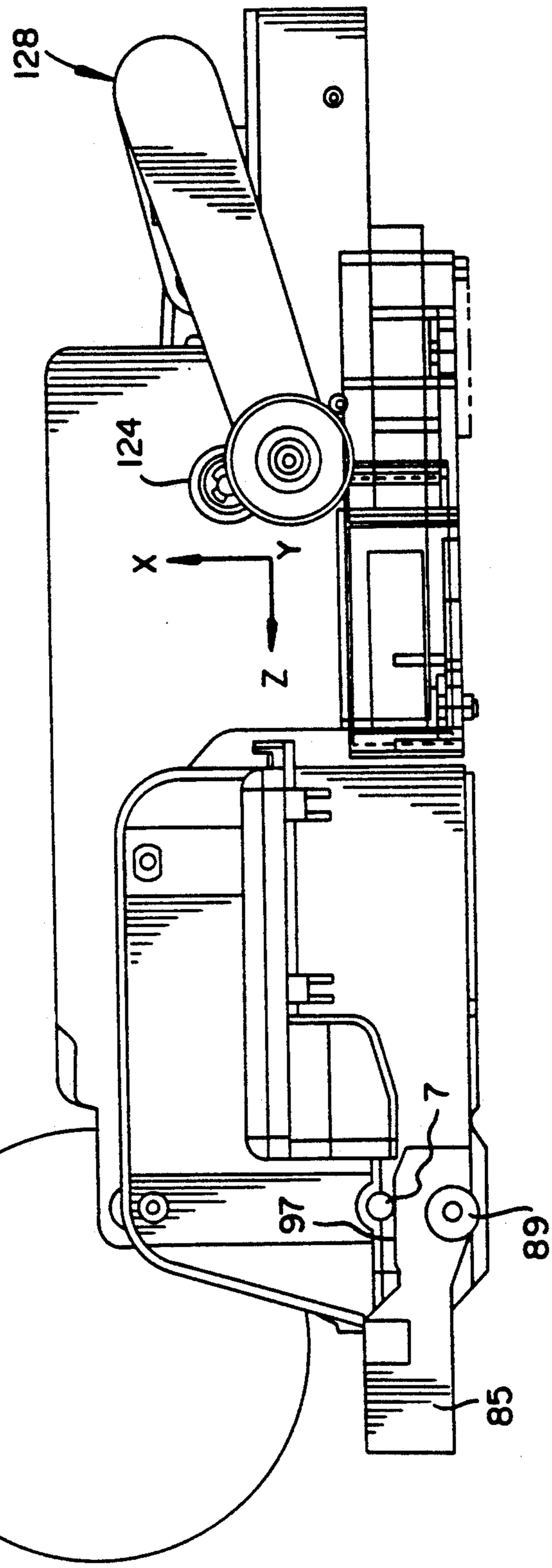


FIG. 8

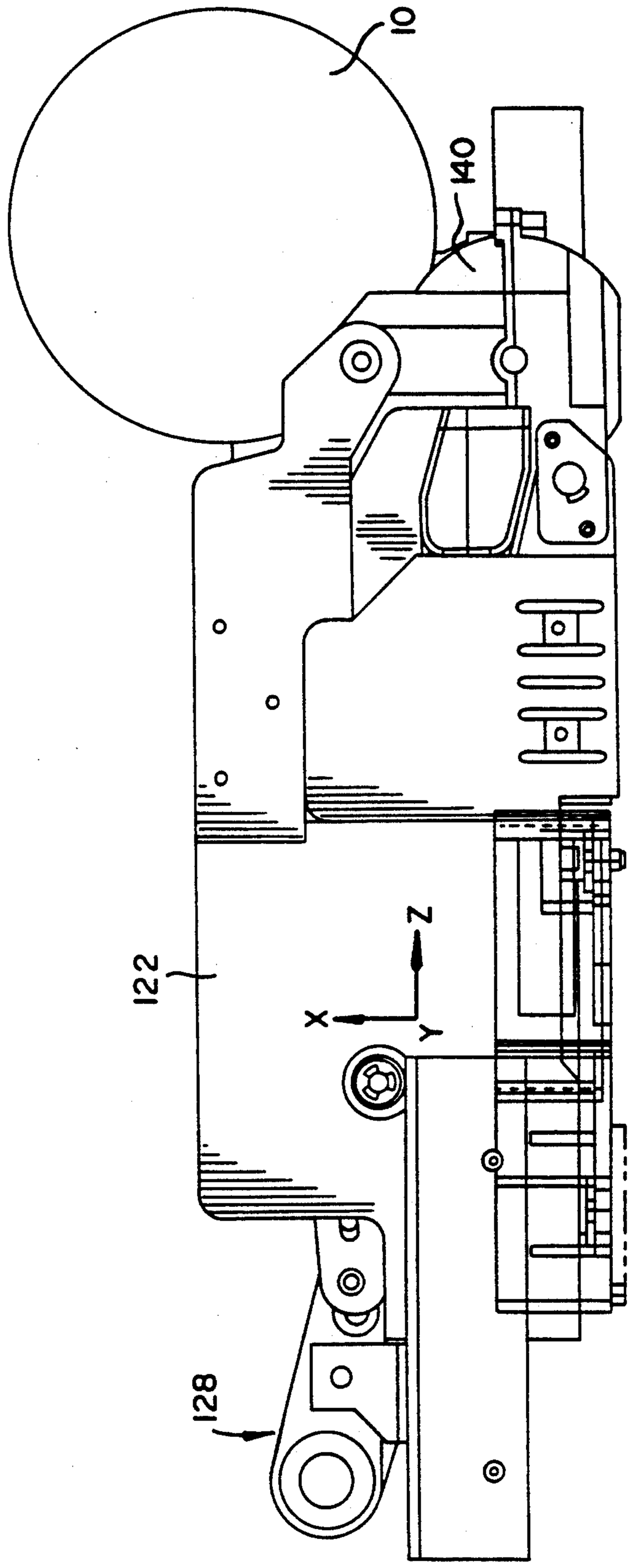
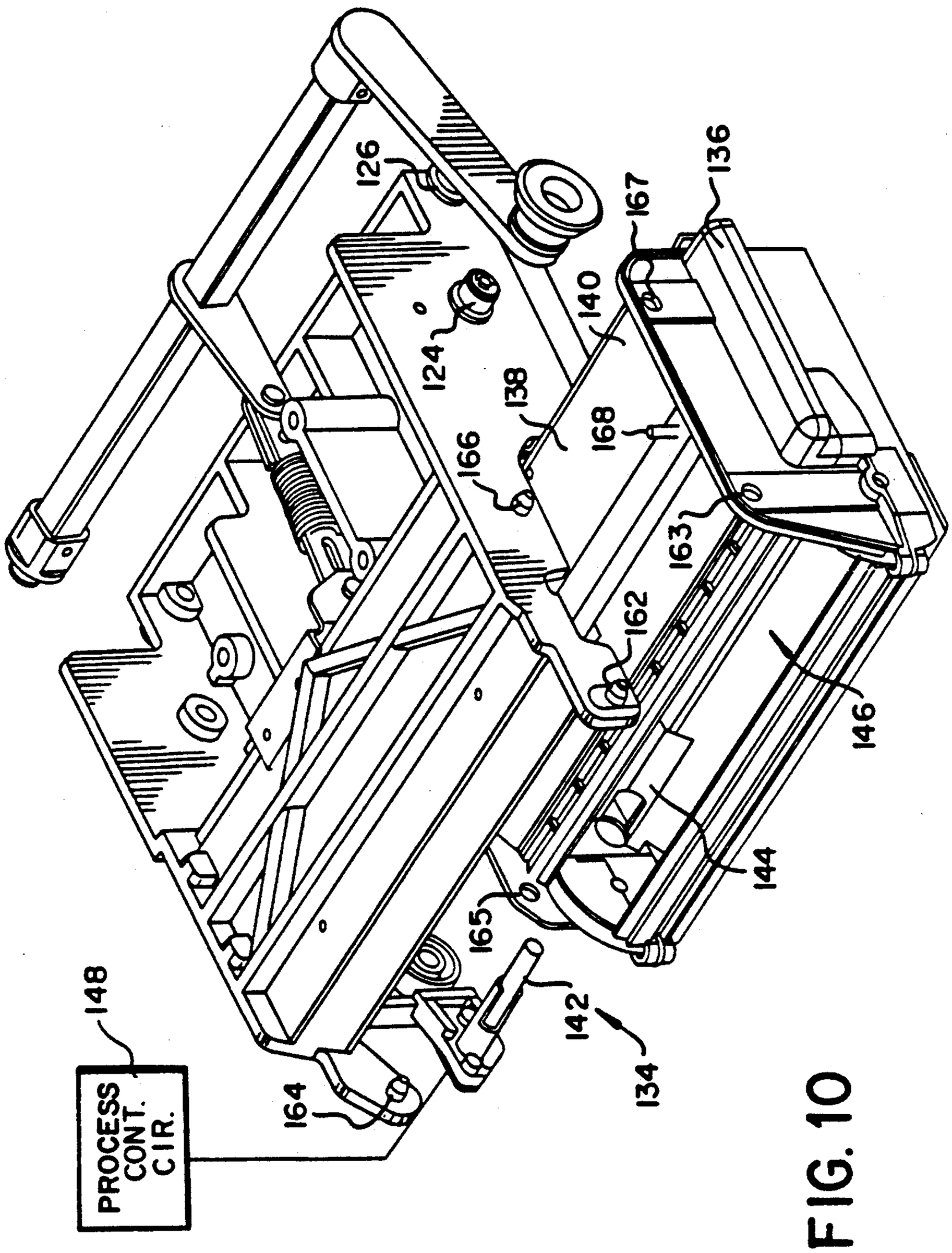


FIG. 9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PROCESS CONT. CIR.

FIG. 10

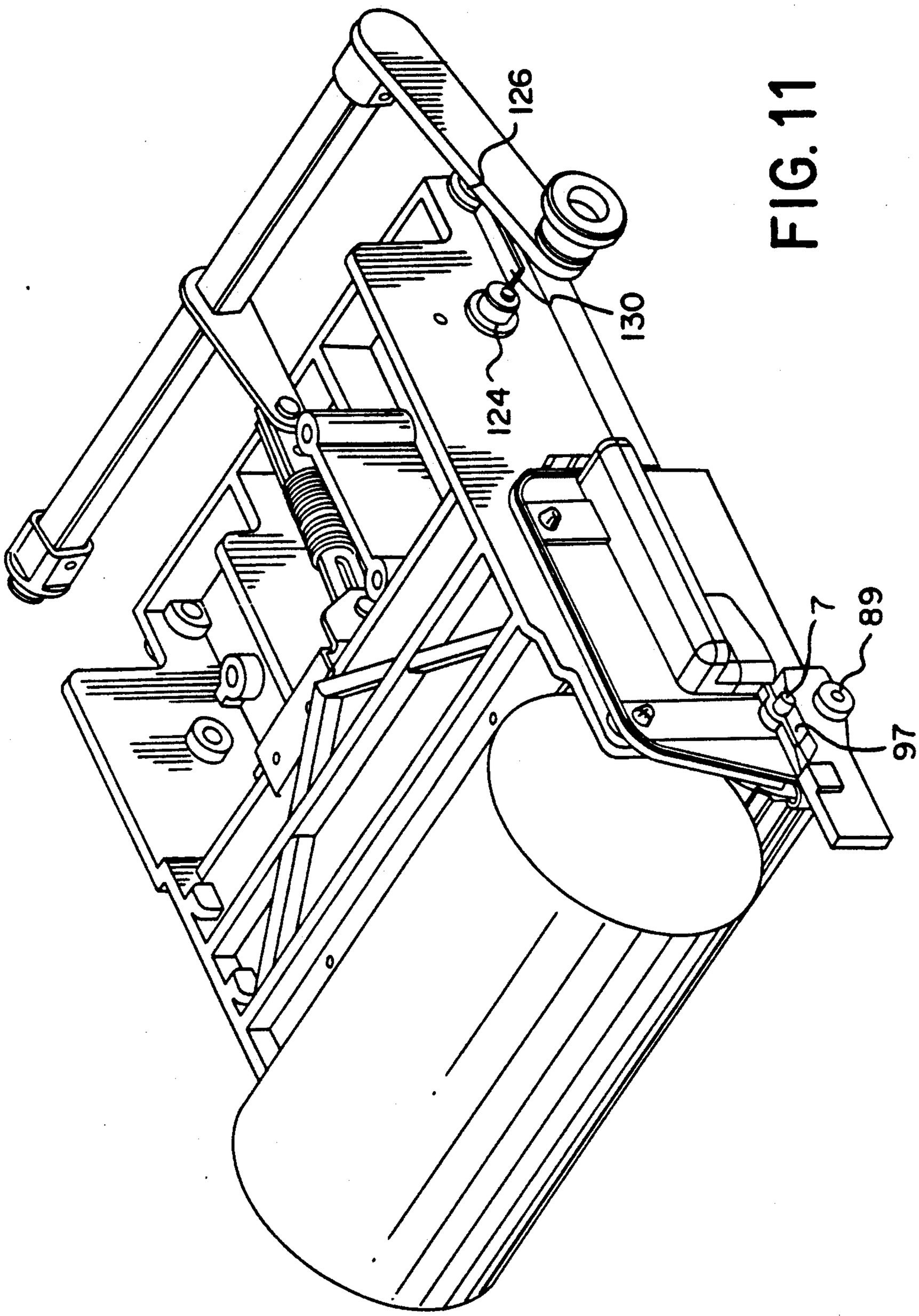
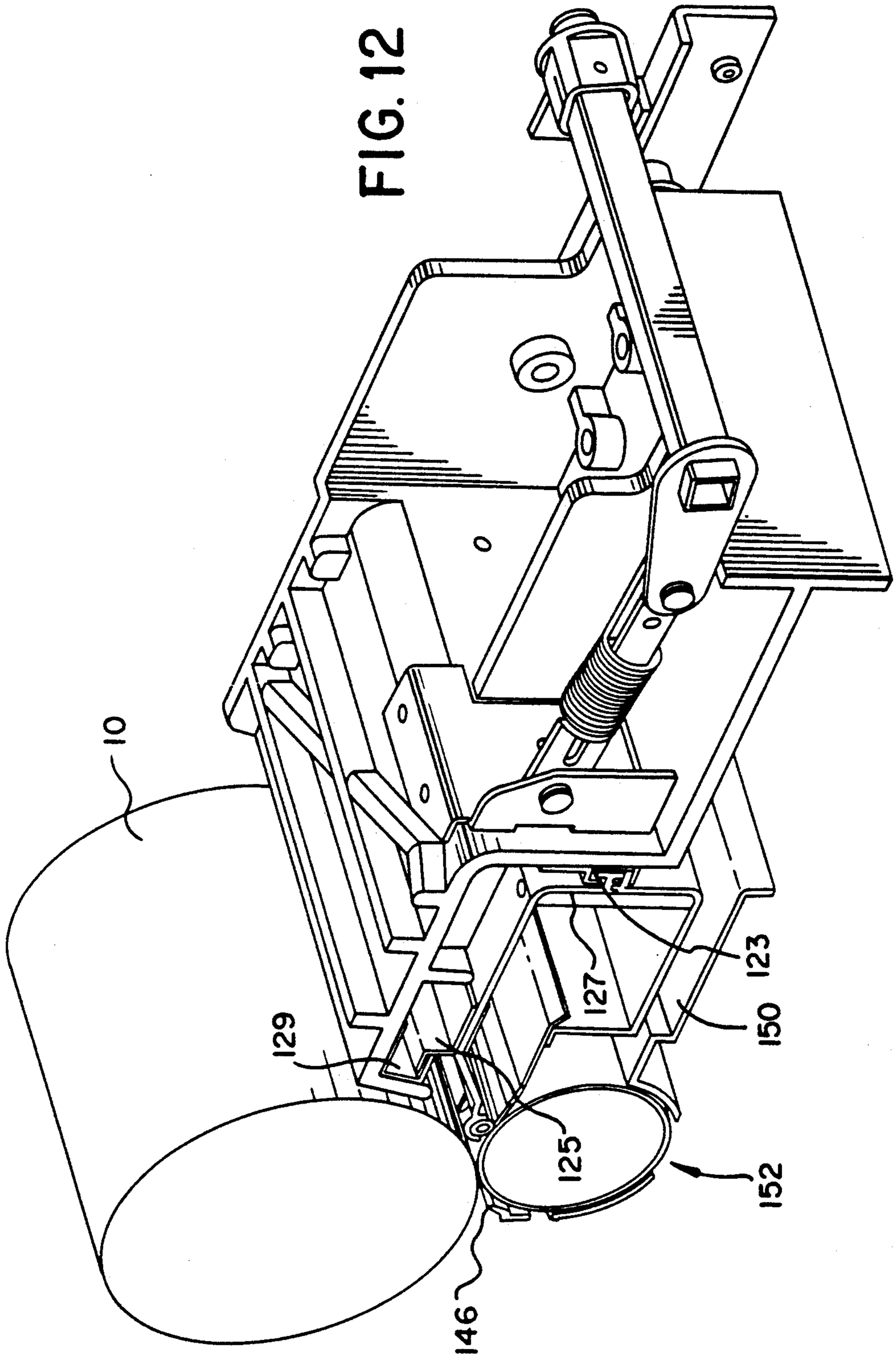


FIG. 11

FIG. 12



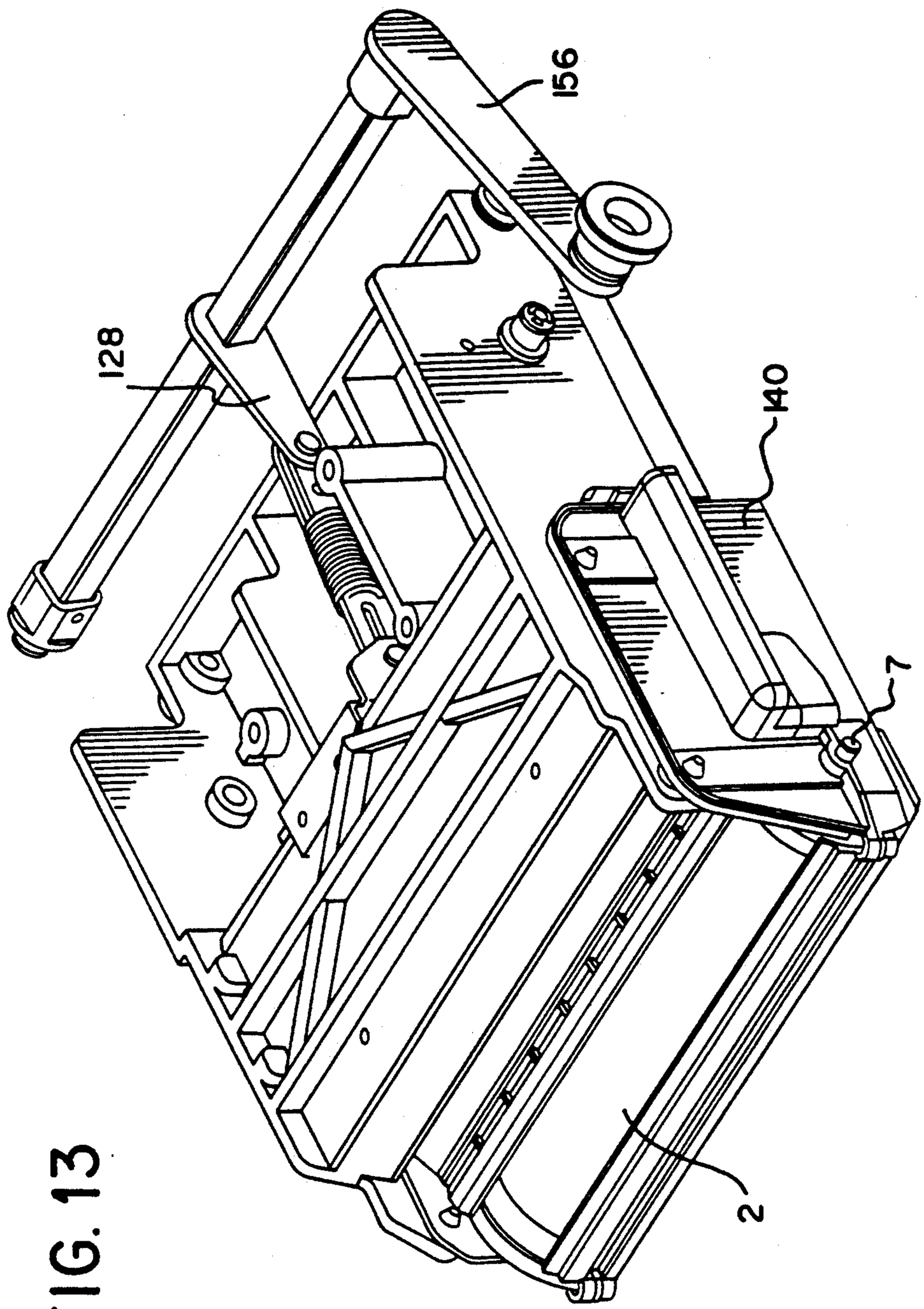


FIG. 13

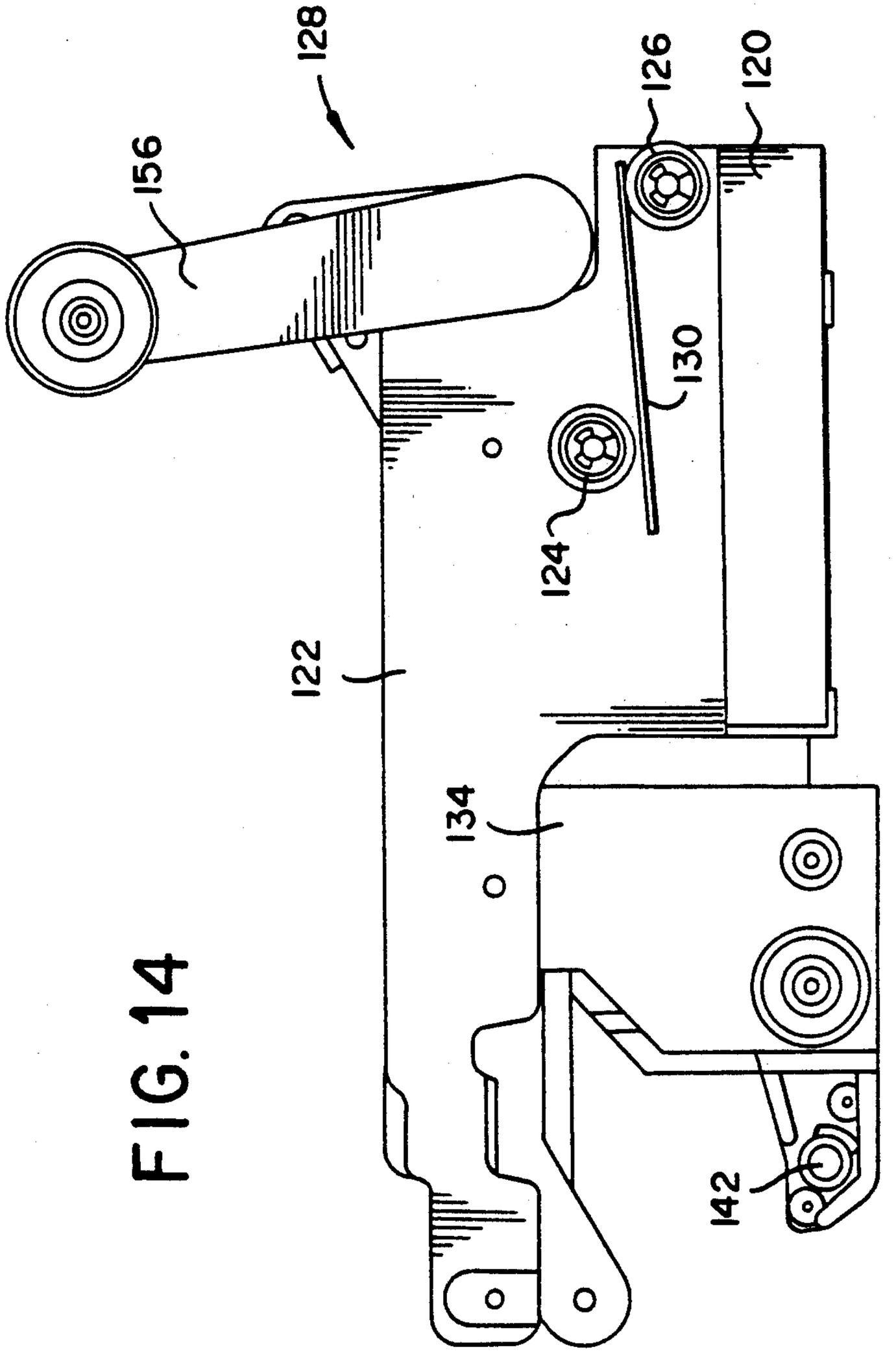
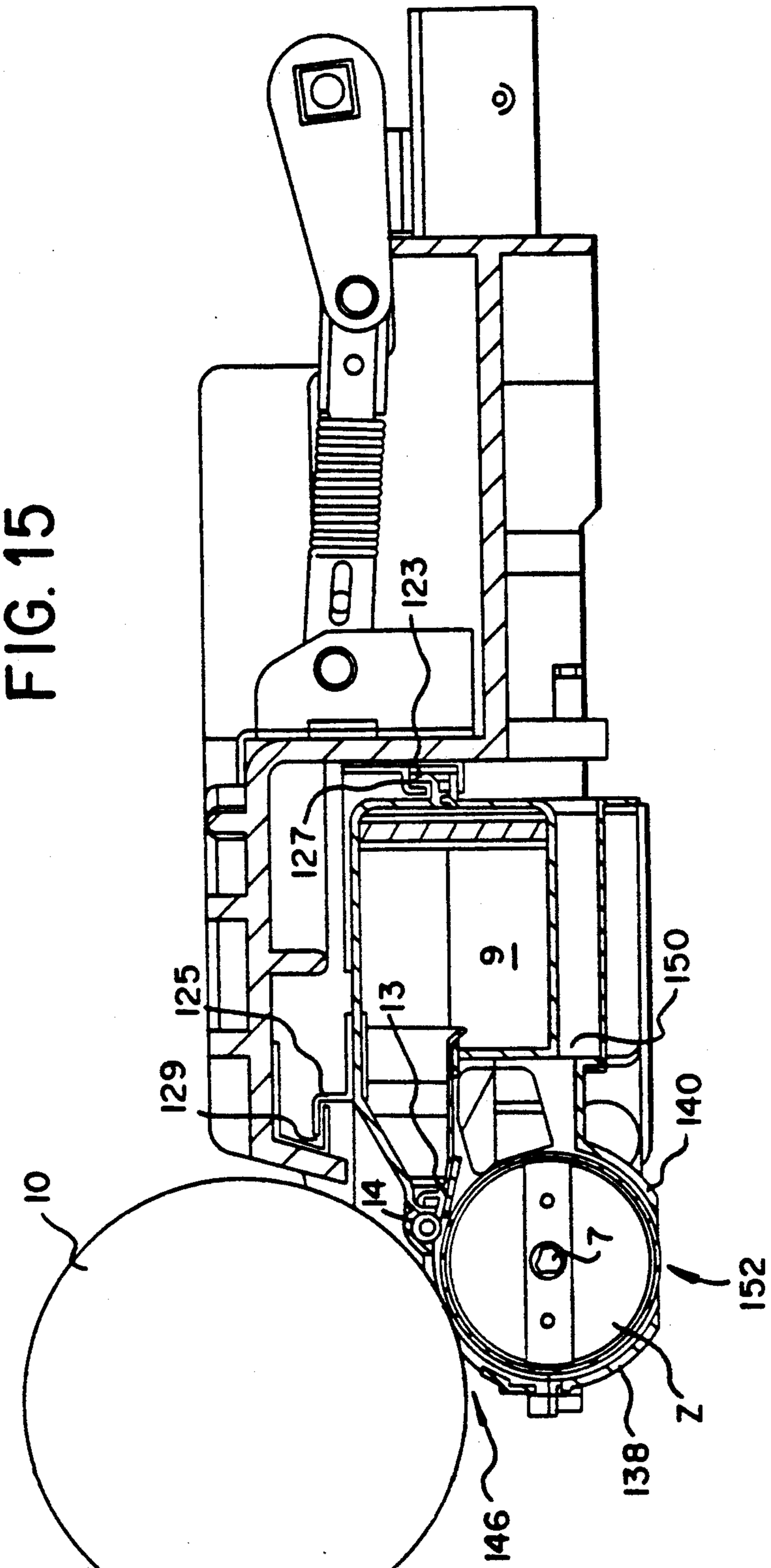
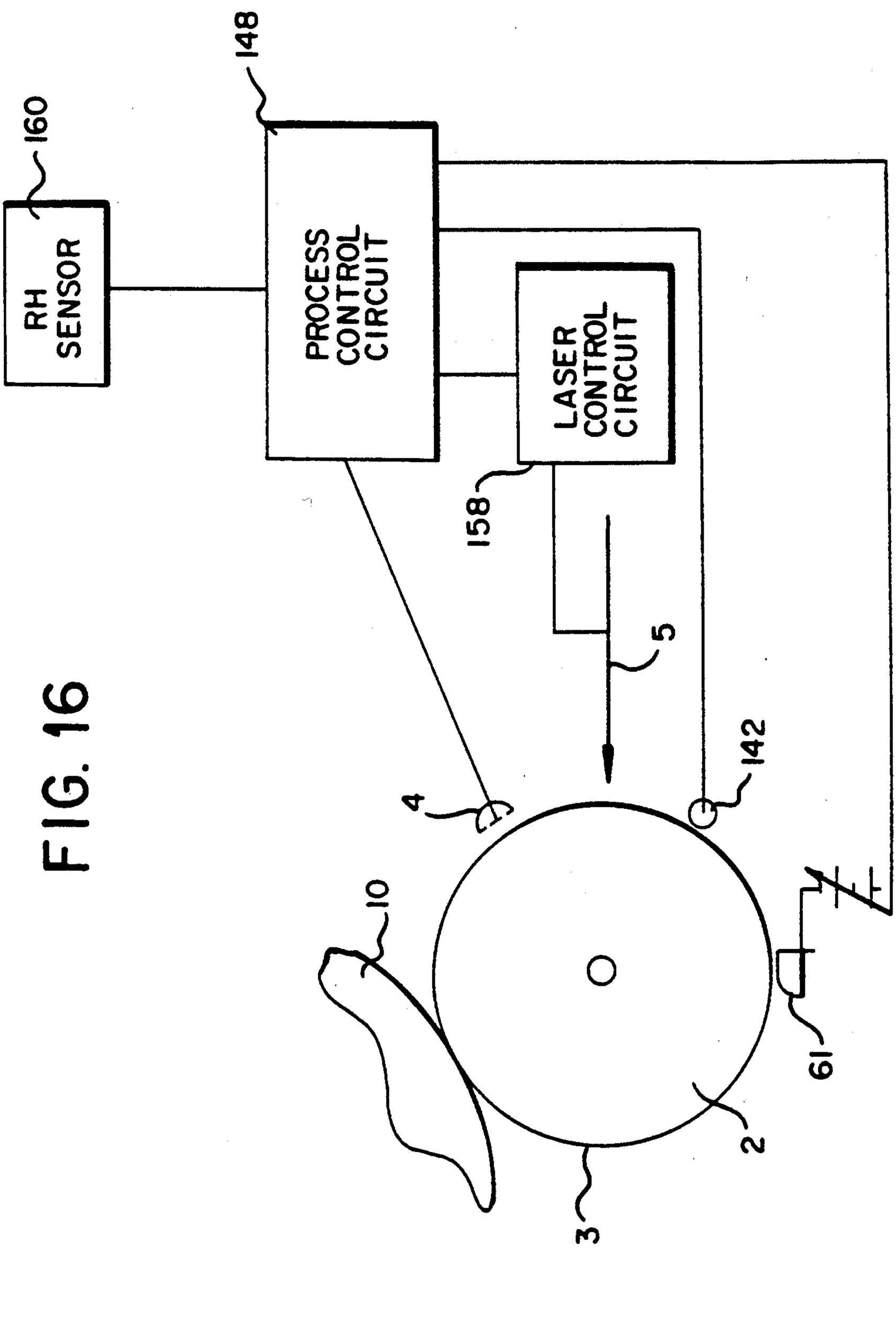


FIG. 14

FIG. 15




148
160
RH SENSOR
PROCESS CONTROL CIRCUIT
LASER CONTROL CIRCUIT
158
5
142
4
10
3
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61
19

FIG. 16

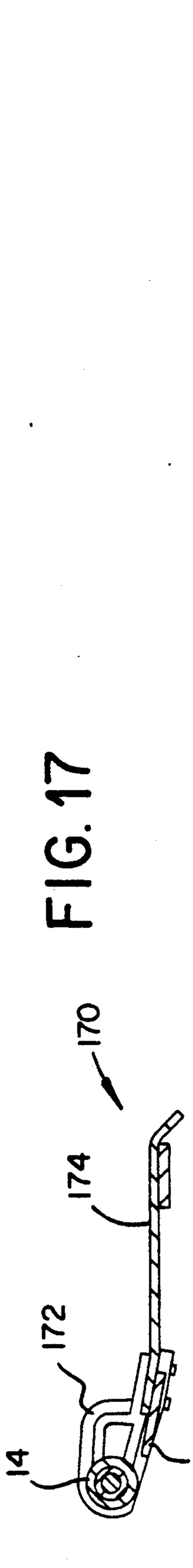


FIG. 17

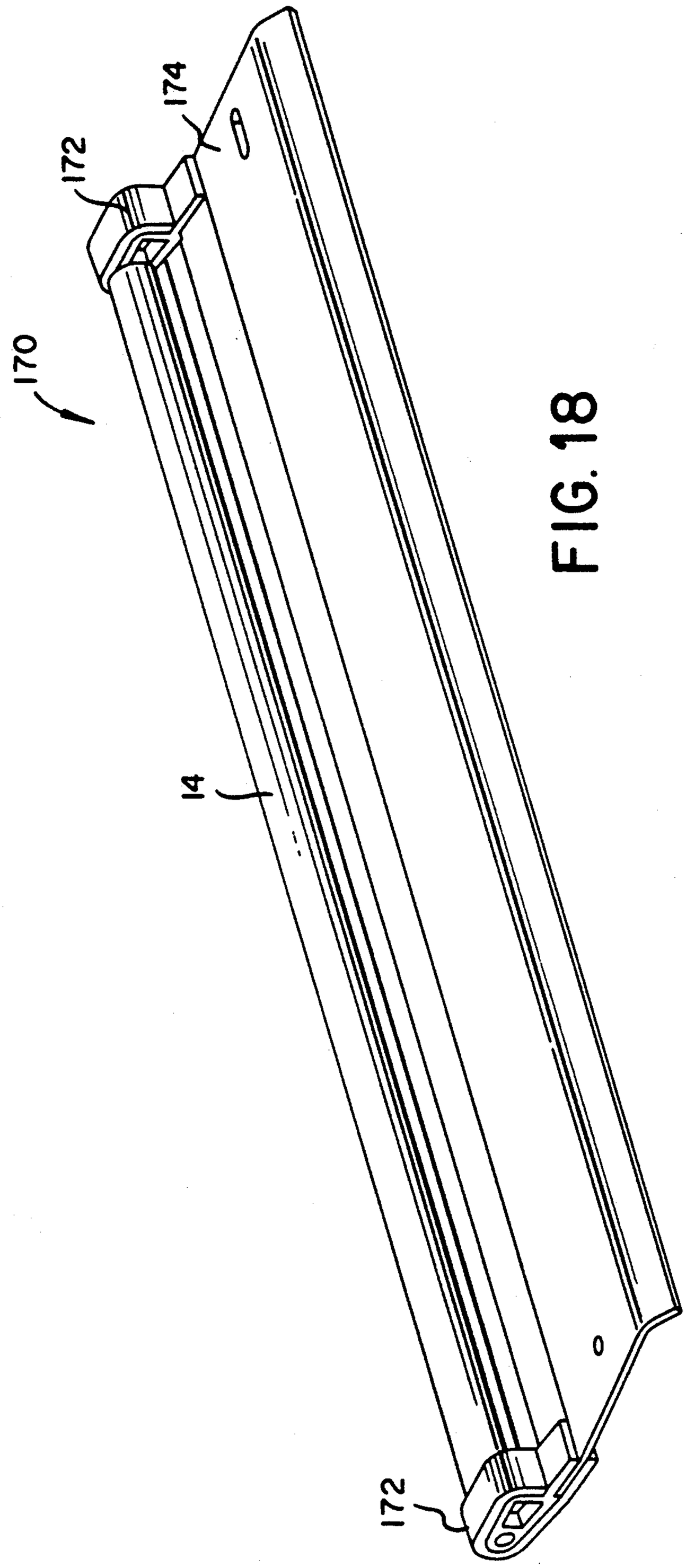


FIG. 18

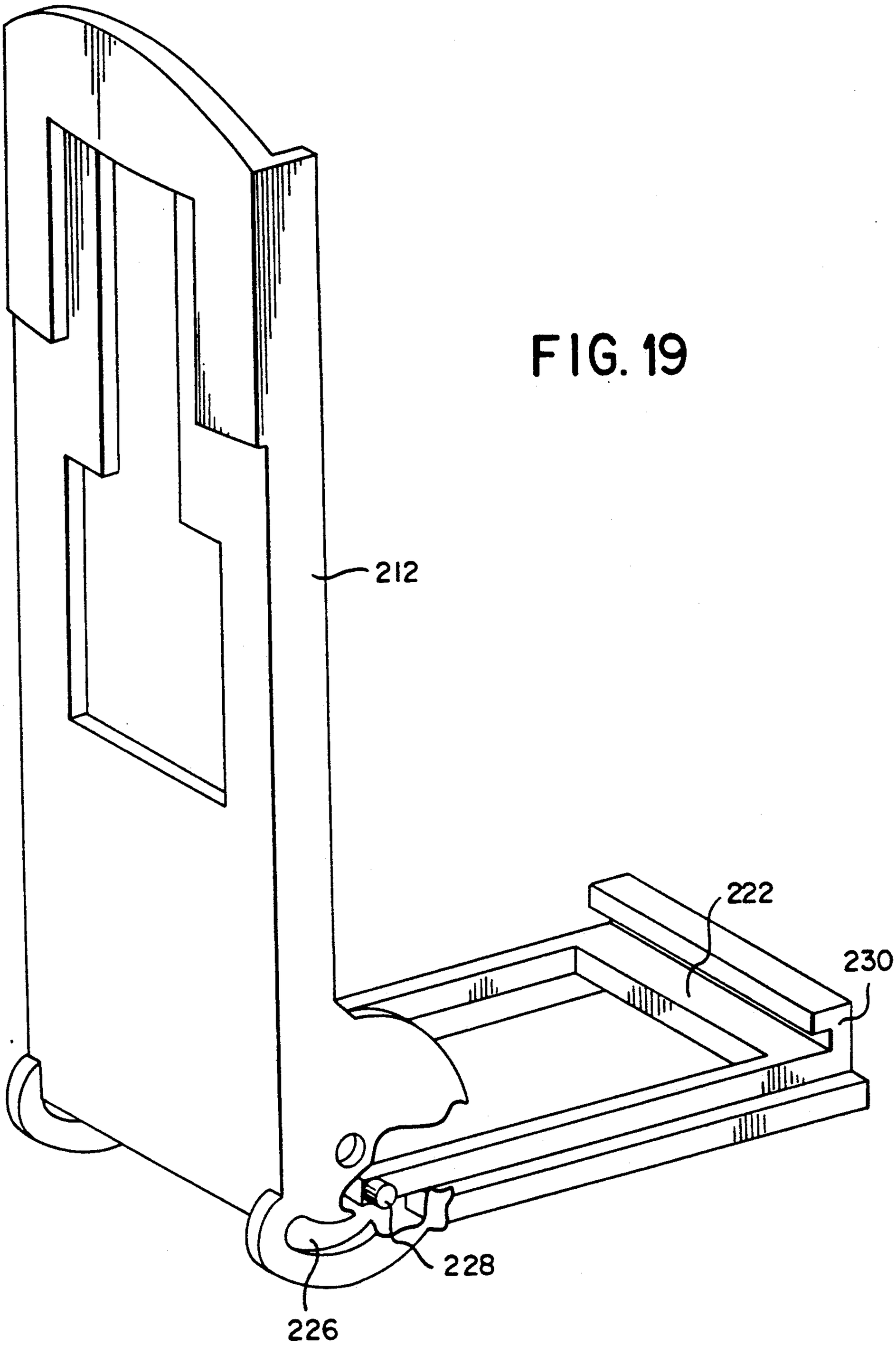


FIG. 19

FIG. 20

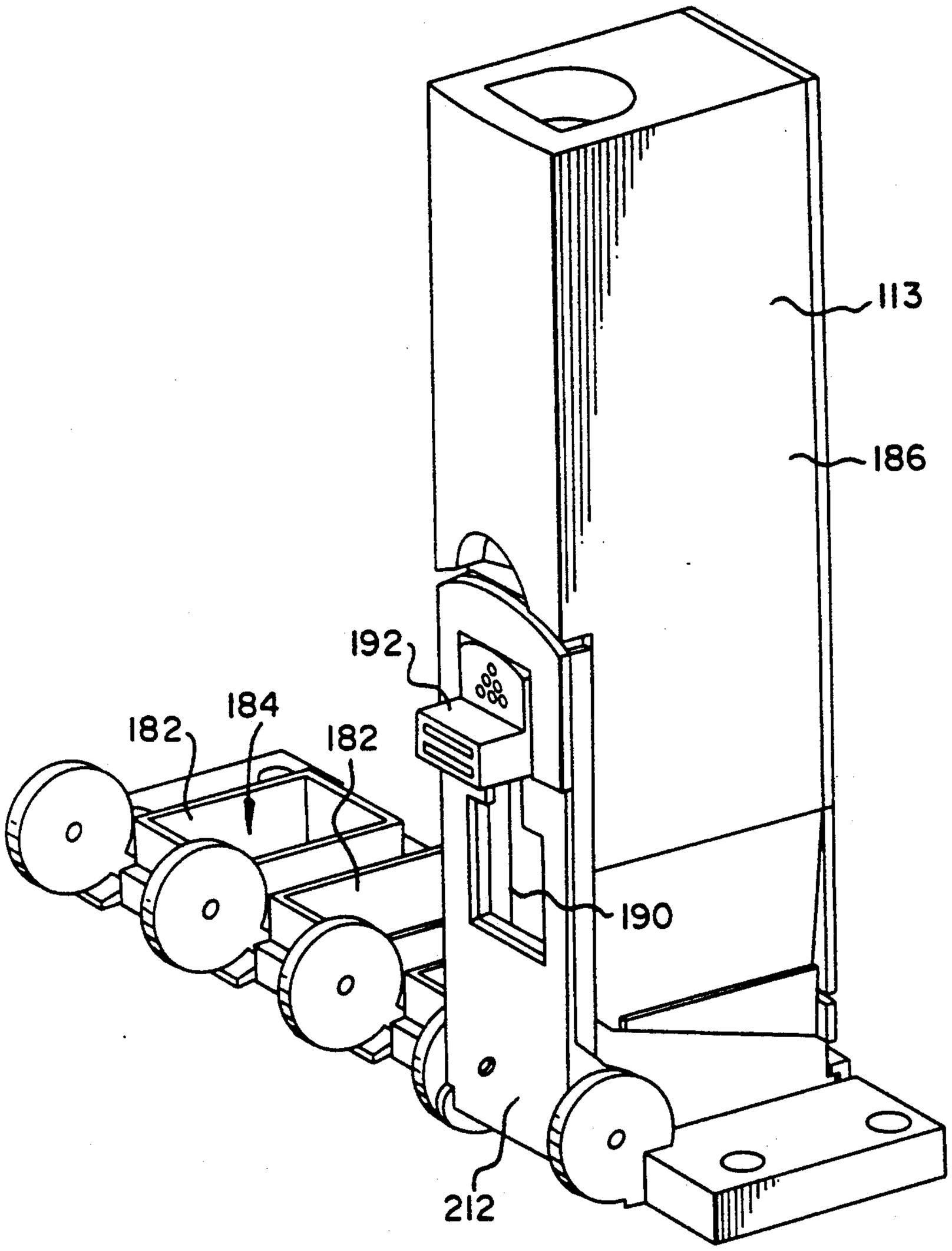
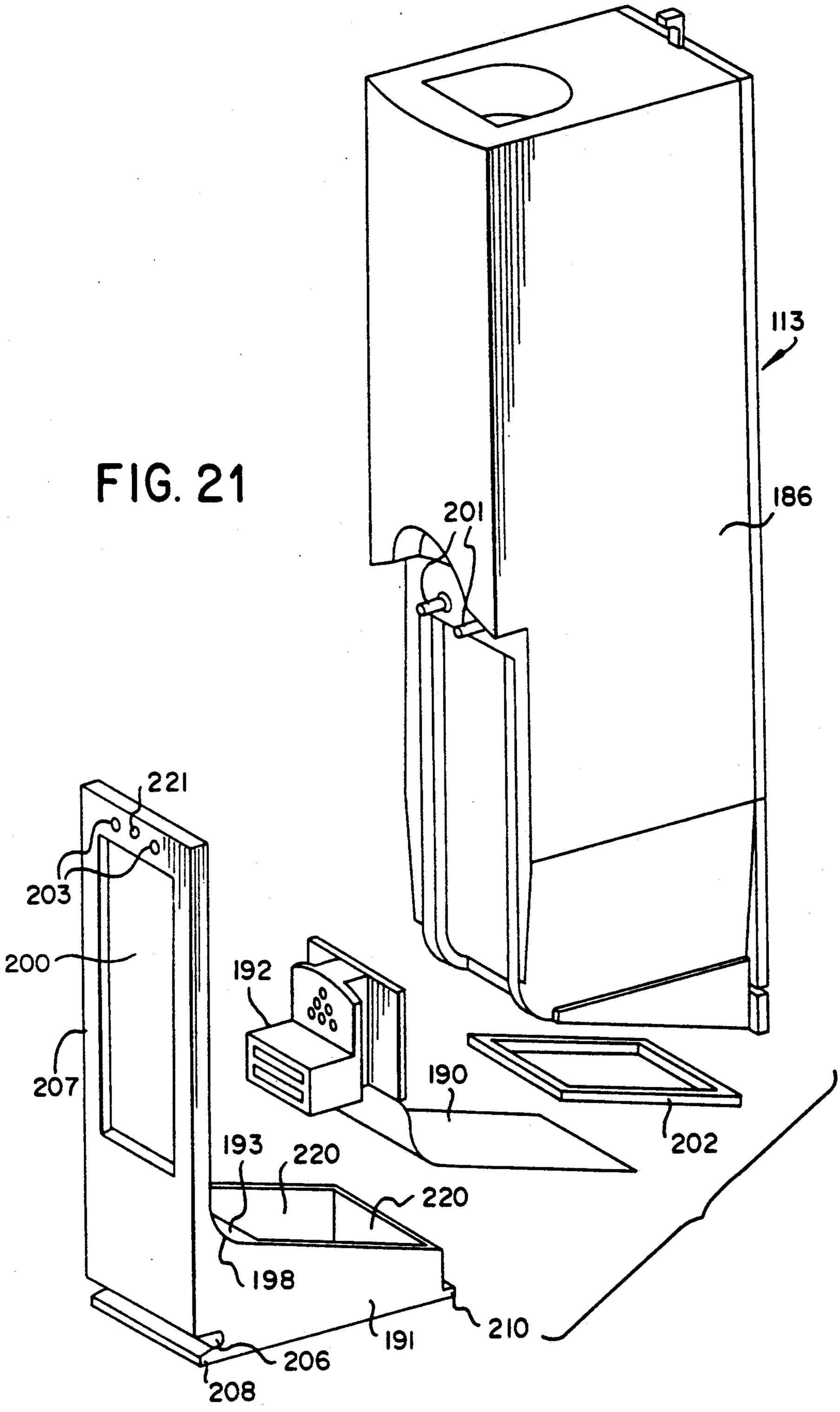


FIG. 21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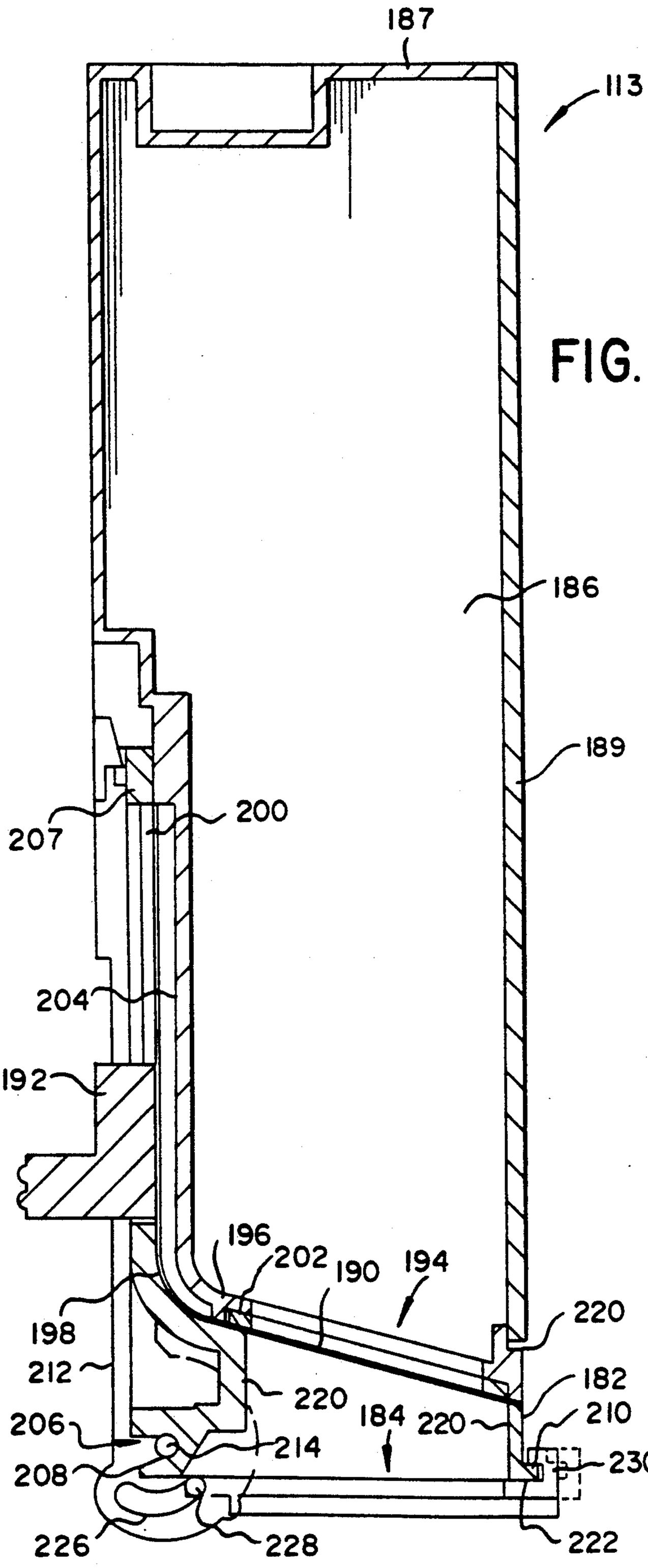
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FIG. 22

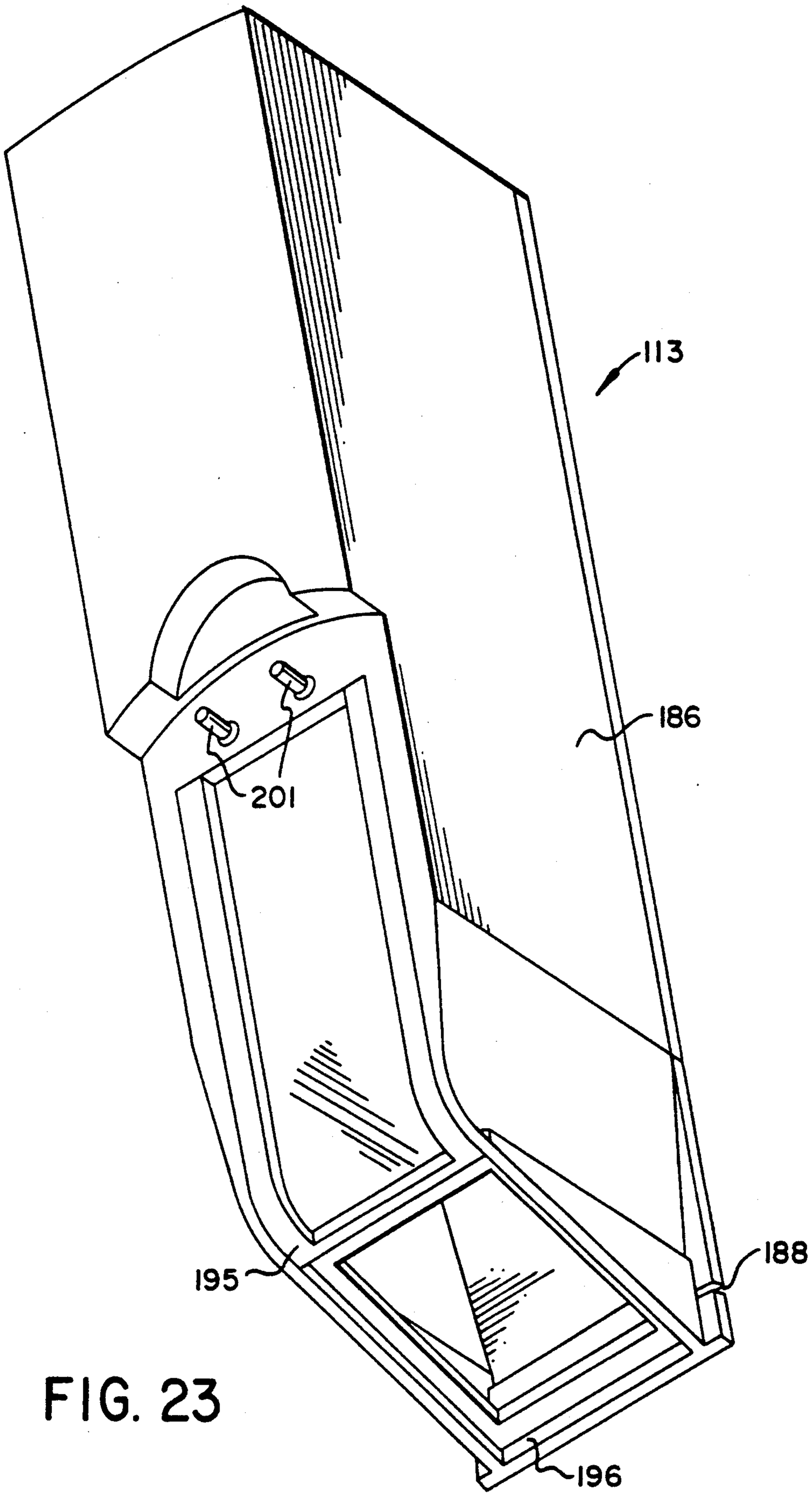

FIG. 23

FIG. 24

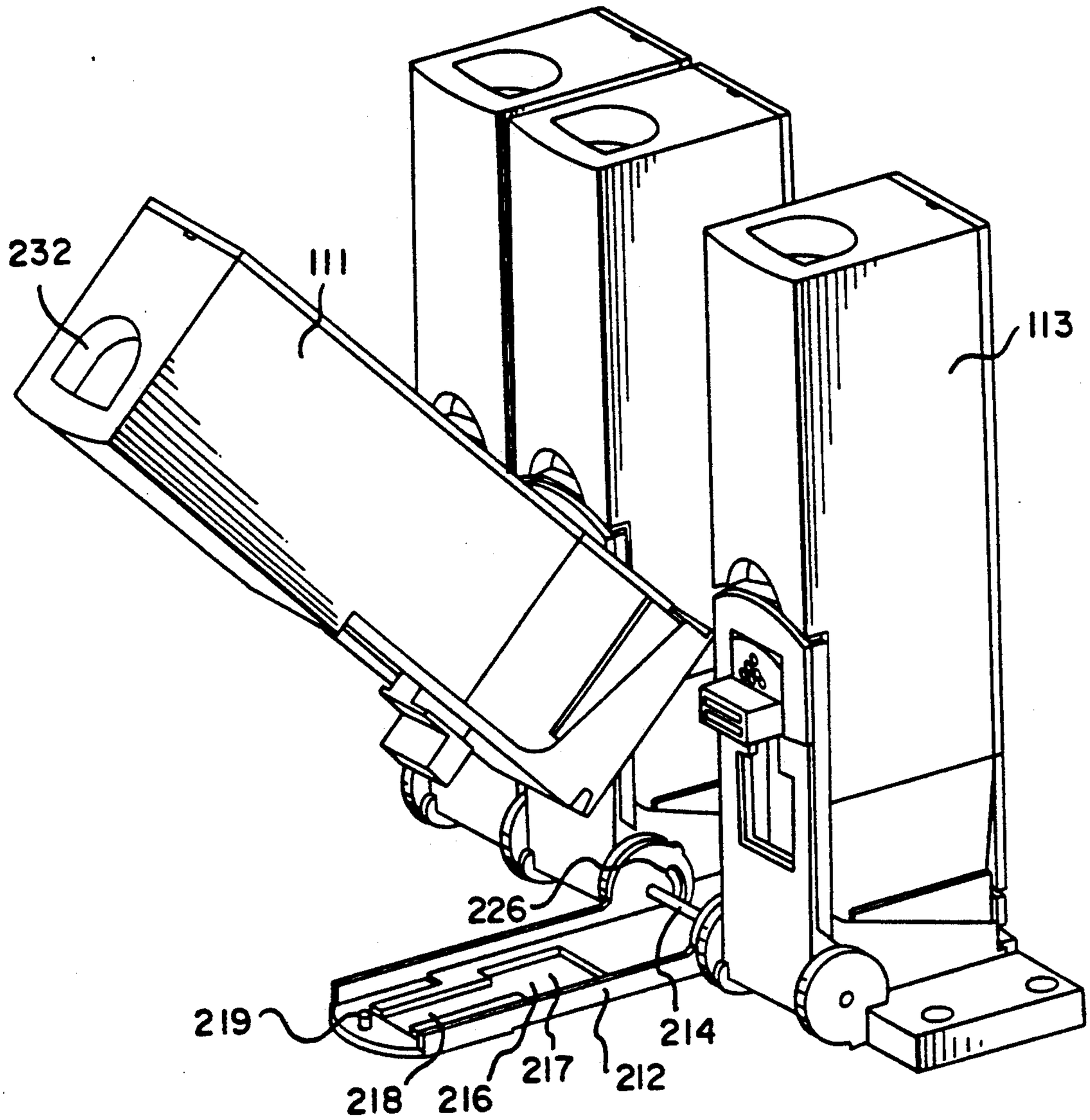

FIG. 25

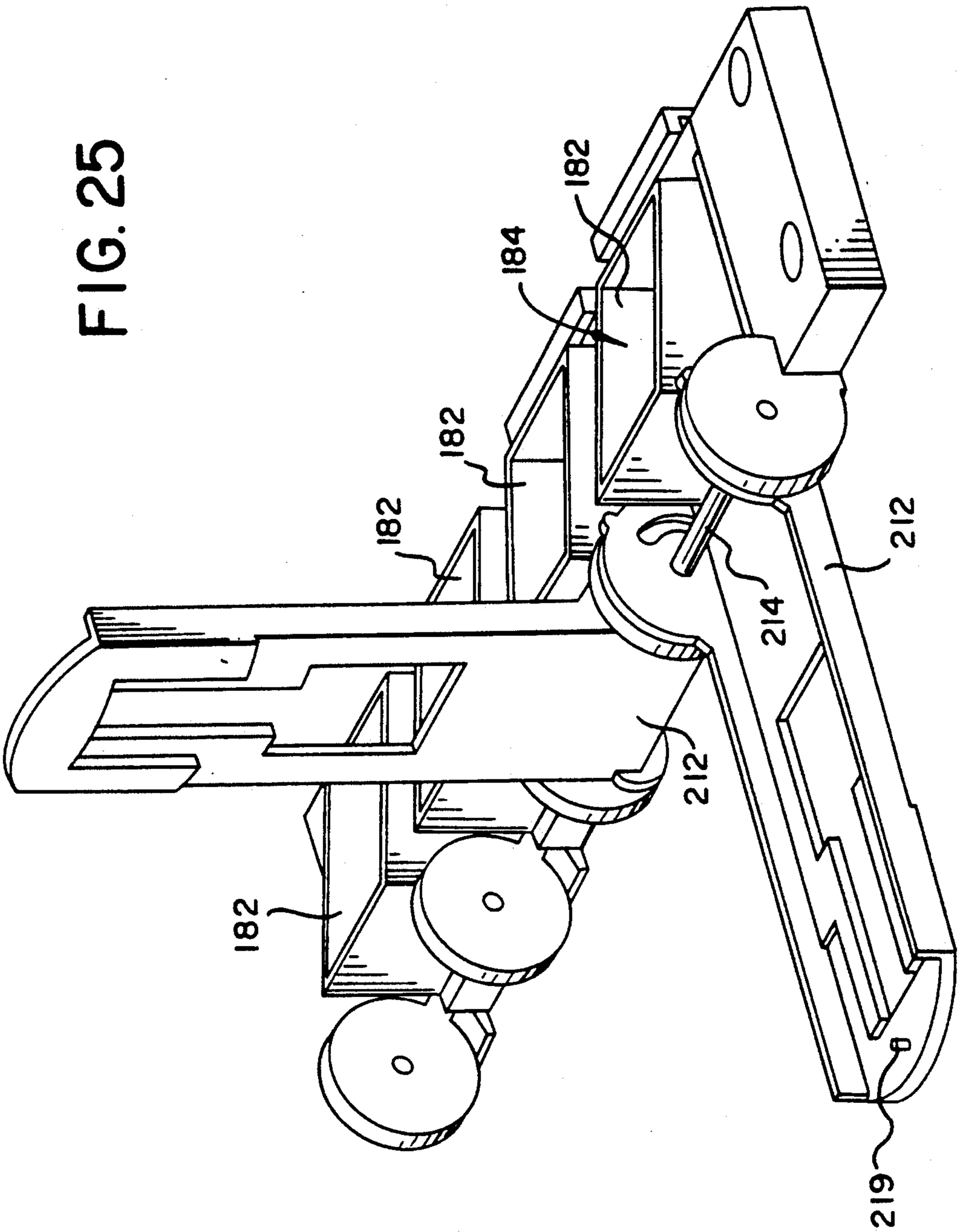

IMAGE FORMING APPARATUS AND AN IMAGE MEMBER CARTRIDGE CONTAINING A PHOTOCONDUCTIVE DRUM

This invention relates to image forming apparatus in which an image member, for example a photoconductive drum, is replaced in the apparatus in a cartridge.

U.S. Pat. No. 4,821,066, issued Apr. 11, 1989 to Foote et al, is typical of a large number of patents showing the use of an electrometer to measure the charge on an image member, for example, a photoconductive image member. The measurement taken by the electrometer is used to create a signal, which signal is used to control an electrophotographic process. For example, the signal can be used to control a primary charger, an exposure device and/or the bias on a development electrode.

In an electrophotographic system in which a photoconductor is uniformly charged and then exposed to create an electrostatic image, the electrometer can be positioned either between the charging station and the exposure station or after the exposure station. Preferably, it is positioned after the exposure station, in which case, a signal can be produced indicative of the effectiveness of both the charging station and the exposure station.

U.S. Pat. No. 5,087,939, issued Feb. 11, 1992 to McDougal, and U.S. Pat. No. 5,138,372, issued Aug. 11, 1992 to DeCecca, show image member cartridges having a photoconductive drum rotatable about an axis of rotation and a housing generally surrounding the drum. The cartridge also contains a charging device, an opening to receive exposing radiation, for example, radiation from a laser, an opening to receive a toning station for toning an electrostatic image and an opening to receive a transfer drum for transfer of a toner image created by the other stations.

The McDougal and DeCecca patents also show a cleaning blade positioned at a one o-clock position to clean toner off the photoconductive drum. A thin polyester flap upstream of the blade is used to prevent toner from entering the cleaning area.

The image forming apparatus described in the McDougal and DeCecca patents is designed to produce multicolor images. Apparatus for producing such multicolor images electrophotographically generally requires substantially higher control of the charging, exposing and developing aspects than does apparatus conventionally providing single color, for example black, images.

U.S. Pat. No. 4,639,119, issued Jan. 27, 1987 to Isaka, shows a photoconductive drum cartridge with a developing station. The developing station includes a sleeve for a magnetic brush, but the magnetic core is permanent in the receiving apparatus and slides into the sleeve when the cartridge is inserted by movement parallel to the axis of the drum.

U.S. Pat. Nos. 3,838,472; 4,131,359; 4,140,380; 4,252,435; 4,323,306 and 4,674,865 show cleaning or collection rollers used in various combinations with blades to increase cleaning effectiveness or remove toner from a cleaning area.

U.S. Pat. No. 4,527,487 to Misawa shows a sealing roller at the upstream edge of a cleaning station for preventing escape of cleaned toner from a blade and roller cleaner located above it.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a process control in an image forming apparatus in which an image member is supplied in an image member cartridge, for example, a photoconductive drum cartridge.

These and other objects are accomplished by an image forming apparatus that includes means for receiving an image member cartridge of the type having an image member movable past a series of stations for forming an electrostatic image on the image member. The image forming apparatus also includes an electrometer which is positioned with respect to the means for receiving the image member cartridge to be operatively spaced from an image member in a receiving cartridge.

According to a preferred embodiment, the image forming apparatus is adapted to receive a cartridge containing a photoconductive drum which is rotatable about an axis of rotation. The cartridge is receivable by sliding movement parallel to the axis of rotation of the drum. The electrometer is positioned to extend from an end of the receiving means and enter an opening in the cartridge to position itself closely and accurately spaced from the photoconductive drum.

With this structure, a relatively expensive electrometer can be permanently positioned in an image forming apparatus and permanently connected into the circuitry for process control of the apparatus. At the same time, the photoconductor, with respect to which the electrometer, must be closely spaced is loadable in the apparatus conveniently in a cartridge.

Thus, it is also an object of the invention to provide an image member cartridge receivable in such image forming apparatus.

It is also an object of the invention to provide a cleaning device for an image member cartridge which controls toner accumulation and escape of toner.

This latter object is accomplished by a cleaning device including a blade biased against an image member surface, a collection area for toner cleaned by the blade and a sealing roller upstream of the blade and rolled by the image member for sealing the cleaning area from escape of cleaned toner. According to a preferred embodiment, rotation of the roller moves cleaned toner across the blade into a collection area surrounding a laser and conveniently positioned opposite the blade from the roller.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective schematic of an image forming apparatus with many parts and all housing eliminated for clarity of illustration.

FIGS. **2** and **3** are perspective views of a development device.

FIG. **4** is a front view of the development device with many parts eliminated and some cooperating structure included.

FIG. **5** is a perspective view of the bottom frame of the development device illustrating a nest for a sump component shown in FIG. **2**.

FIG. **6** is a schematic front section of the sump component showing its relationship with four applicators.

FIG. **7** is a right side view with portions in section of the development device.

FIGS. **8** and **9** are front and back views, respectively, of a laser chassis with a photoconductive drum cartridge inserted in it.

FIGS. 10, 11, 12 and 13 are perspective views of the laser chassis and the photoconductive drum cartridge.

FIG. 14 is a front view of the laser chassis without the photoconductive drum cartridge.

FIG. 15 is a front section of a laser chassis and the photoconductive drum cartridge.

FIG. 16 is an electrical schematic illustrating process control circuit.

FIGS. 17 and 18 are a front section and a perspective view of a cleaning blade component.

FIG. 19 is a perspective view of a locking structure for locking a toner container on a receiving apparatus.

FIGS. 20, 24 and 25 are perspective views of the toner container receiving apparatus with one, three and no containers received, respectively.

FIG. 21 is a perspective view of a toner container with four parts separated illustrating its assembly.

FIG. 22 is a side section of a toner container.

FIG. 23 is a bottom perspective view of a containing portion of a toner container.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The invention is particularly usable in an image forming apparatus, for example, a desktop color printer 1 shown schematically in FIG. 1. Printer 1 includes an image member, for example, a photoconductive drum 2 which is journaled for rotation through operative relation with a series of stations including a charging station 4 which lays down a uniform charge on an outer cylindrical image surface 3 of image member 2. The uniformly charged image surface 3 is imagewise exposed by an electronic exposure device, for example, a laser 5 to form a series of electrostatic images.

The electrostatic images are toned by applying toners of different colors by a development device 6 to create a series of different color toner images on image surface 3. The different color toner images are transferred in registration to the outside surface of a transfer drum 10 to form a multicolor image as transfer drum 10 repeatedly rotates through transfer relation with photoconductive drum 2.

The multicolor toner image on the surface of transfer drum 10 is transferred to a receiving sheet fed from a receiving sheet supply 45 into transfer relation with drum 10 at a transfer station 21. The receiving sheet is then fed to a fuser 23. The multicolor image is fused to the receiver sheet by the application of heat and pressure. The receiving sheet with fixed multicolor toner image thereon is then conveyed through an inverting path to an output hopper already containing other receiving sheets, as shown at 44. The transfer drum 10 is cleaned by articulatable cleaner 30 after the transfer of the multicolor image. The photoconductive drum 2 is continuously cleaned by an image member cleaning device 12.

As will be described in more detail, development device 6 includes four toning stations, each containing a different color toner. Device 6 is moved horizontally to sequentially present the stations to image member 2 to apply the different toners to the images at a single development position. As also will be described in more detail, to easily replace the photoconductive drum 2, charging device 4 and cleaning device 12, they are all included in an image member cartridge, also shown in more detail below.

The development device 6 and its operation is shown in FIGS. 2–7. Referring first to FIG. 4, development device 6 includes a carriage 31 supported by wheels 33 which rest on a floor 35 for transverse movement under photoconductive drum 2. The carriage 31 is driven by a transverse drive motor 37 (FIGS. 2 and 3) which drives a pinion (not shown) engaging a rack 39 on floor 35, as shown in FIG. 3. Guide wheels, not shown, engage opposite sides of rails integral with the rack to maintain accurate straight-line transverse movement of carriage 31.

Carriage 31 supports four developing units 15, 16, 17 and 18 (FIG. 4). Each developing unit 15, 16, 17 and 18 includes a sump 25, 26, 27 and 28 and an applicator 55, 56, 57 and 58, respectively. As seen with respect to unit 15 in FIG. 4, sump 25 includes a rotatable paddle 51 and a pair of augers 53 which are geared together to mix developer in the sump. The applicator 55 includes a stationary shell 61 and a rotatable magnetic core 63 inside the shell.

This type of developing unit is well known in the art. Briefly, a developer comprising a mixture of hard magnetic carrier particles and toner in sump 25 is moved around shell 61 by the rotation of magnetic core 63 to bring the developer through a development position 8 between the top of shell 61 and the image surface 3 of photoconductive drum 2. The shell 61 and the image surface 3 must be accurately spaced for high quality development of an electrostatic image carried by image surface 3. The developer is continually mixed and made available to applicator 55 by rotation of paddle 51 and augers 53.

Movement of carriage 31 from left to right, as shown in FIG. 4, indexes the development units 15, 16, 17 and 18 through the development position 8 to apply toner to develop a series of electrostatic images on image surface 3 with different color toners. The different color toner images, as previously described, are superposed in registration on transfer drum 10 to create a multicolor image.

As seen in FIG. 2, sumps 25, 26, 27 and 28, together with their paddles 51 and augers 53, comprise a single sump component 54 which is integrally formed and separately removable from carriage 31. Sump component 54 can be made of a unitary plastic construction which defines the sumps themselves, and also defines extended portions 59. Extended portions 59 do not fit under the applicators 55–58. The paddles 51 are mounted for rotation within the sumps 25–28 while the augers 53 in the bottom of the sumps extend into extended portions 59. Conventional toner replenishers 63 (shown in FIGS. 2, 3 and 7) are positioned to be directly over the extended portions 59 when the sumps are in their operative position. Replenishers 63 are driven by replenisher motors, shown covered by a replenisher motor cover 65, to meter toner under the force of gravity down onto the augers 53 in extended portions 59 on demand by the apparatus. Toner is received in the replenishers 63 from toner bottles 110, 111, 112 and 113 whose function will be described in more detail with respect to FIGS. 19–25.

As described above, the sumps 25, 26, 27 and 28 contain developer which is a mixture of carrier and toner. The toner is used up in the developing process and is replenished from the toner bottles by replenisher 63. Thus, new toner is constantly being mixed with the developer in the sumps. However, after a certain amount of use, for example 25,000–50,000 images, the carrier loses its effectiveness and must be replaced. In a high volume copier, this is commonly accomplished by a serviceperson in a periodic service call. However, in a

desktop printer, such a replacement must be made by a relatively untrained operator. This is accomplished by entirely replacing sump component **54** periodically. That is, sump component is slid into and out of a nest **67** under the applicators and the replenisher. The applicators and replenisher are permanent parts of development device **6**. Nest **67** is best seen in FIG. **5**, which also shows a pair of springs **69** which urge sump component **54** against an opposite wall **52** of the nest **67** to releasably hold sump component **54**.

Thus, sump component **54** is a single unitary component which includes the sumps for all four development units and an extended portion for receiving toner, as well as inexpensive plastic paddles and augers, and is replaceable periodically to replace the carrier in the development device. The much more expensive and critically positioned applicators and toner replenishers are permanent in the apparatus.

When the sump component **54** is moved fully into the nest **67**, an engageable coupling on the leading end of sump component **54** engages four engageable drives **66** at the rear of nest **67**, which drives the paddles and augers. Two embodiments of such drives will be explained more fully below.

FIG. **6** is a schematic front section of the sump component **54** and showing its relationship with the applicators **55–58**. FIG. **7** is a side section which illustrates the relationship between the toner containers **110–113**, the replenisher **63** and the extended portion **59** of sump component **54**.

As mentioned above, vertical positioning of the applicators **55**, **56**, **57** and **58**, with respect to the image surface **3** of photoconductive drum **2** at the development position **8**, is critical to consistent development of the electrostatic images on surface **3**. Accuracy in this vertical spacing in apparatus in which the photoconductive drum **2** is received in a cartridge and in which the development units **15**, **16**, **17** and **18** are constantly being indexed into and out of position, is challenging. This is further complicated by a desire not to directly engage drum **2** or its cartridge with moving applicators or their supports because any jar to the drum **2** or its cartridge will affect accurate exposure by laser **5** and cause image defects.

Referring primarily to FIGS. **3** and **4**, the applicators **55**, **56**, **57** and **58** are fixed as part of an applicator component **71** which includes all four applicators, a first rail **73**, a second rail **75**, separators **77** and a support **79** fixing the applicators, rails and separators permanently with respect to each other. The applicator component **71** is gimbaled to the carriage **31** by three spring and pin assemblies **81** shown in FIGS. **2** and **3**. The springs urge the applicator component in an upward direction to a point at which they support its weight. A first positioning member **83** and a second positioning member **85** are permanently mounted in printer **1** and firmly located with respect to transfer drum **10**. A first wheel **87** is mounted on first positioning member **83** just above the desired development position **8**. A second wheel **89** is mounted to second positioning member **85** and is positioned just above the opposite end of the development position **8**. The first and second rollers ride on first and second rails **73** and **75**, respectively, and accurately space each applicator vertically when it reaches the development position. A third roller **91** and a fourth roller **93** are positioned to alternatively engage first rail **73** to prevent rail **73** and thereby applicator component **71** from deviating from a horizontal orientation. Rail **73** is longer than the distance between first roller **87** and either third roller **91** or fourth roller **93** but is shorter than the distance between third roller **91** and fourth roller **93** so that it never contacts more than one of third roller **91** and fourth roller **93**. Thus, the first and second rollers accurately control the vertical positioning of the applicator at the toning position while one of the third and fourth rollers maintains horizontal orientation of the applicator component **71**. FIG. **7** also illustrates the first and second rollers **87** and **89** and the first and second rails **73** and **75** in spacing applicator **55** from photoconductive drum **2**.

The first and second positioning members **83** and **85** contain first and second horizontal positioning surfaces **95** and **97** on their upper side. Photoconductive drum **2** includes a shaft **7** with opposite ends extending beyond the drum **2**. The photoconductive drum **2** is urged to the left by a suitable spring, described in more detail below, but shown schematically in FIG. **4** at **100**. This urging of the photoconductive drum **2** to the left causes the ends of shaft **7** to engage the positioning surfaces **95** and **97** with the photoconductive drum **2** essentially wedged between transfer drum **10** and the positioning surfaces **95** and **97**. Positioning surfaces **95** and **97** are horizontal and are accurately located with respect to each other and with respect to transfer drum **10**.

This construction allows accurate vertical positioning of the image surface **3** of photoconductive drum **2** with respect to an applicator at the development position **8** as well as maintaining the axes of rotation of drums **10** and **2** parallel with each other. Drum **2** is loaded in the apparatus in a cartridge. Horizontal positioning, that is, positioning from left to right, is not tightly controlled. However, if the top of the applicators **55–58** are relatively flat, as shown, horizontal positioning is much less critical than vertical spacing. Horizontal positioning is, of course, also affected by accuracy in the transversing drive of carriage **31**. Control of the transversing drive is best accomplished by suitable sensors, for example, optical sensors (not shown) associated with each of the developing units.

FIGS. **2** and **5** illustrate a first embodiment of the drives for the applicators, paddles and augers. The paddle and augers for each developing unit are geared together at the rear end of each unit. A paddle shaft **106** extends from the rear of the sump component **54** with gearing that is part of sump component **54**. Complete insertion of the sump component **54** by the operator into the sump component nest **67** couples the paddle shaft with a paddle drive **66**, shown in FIG. **5**.

The magnetic core **63** of each of the applicators **55–58** also includes an applicator shaft **102** which extends to the rear of applicator component **71** and first rail **73**. The applicator shafts **102** engage drive gears **70** on their sides, as shown in FIG. **2**. The applicator shafts move slightly along the sides of the gears **70** to accommodate for any vertical movement of the applicator component **71**. Drives **66** and **70** are connected into a gear box **72** driven by a motor **74**, all of which is carried by carriage **31**.

FIG. **7** illustrates an alternate and generally preferred drive mechanism for the applicators and the paddles and augers. More specifically, each applicator shaft **102** is couplable to a single applicator drive **105**. The paddle shaft **106** is couplable with a single paddle drive **107**. The applicator drive **105** and the paddle drive **107** and a drive box **115** containing a motor are mounted together as a drive unit and are positioned to the rear of

the development position, as seen in FIG. 7. This drive unit does not move with the carriage **31** but is movable from the rear toward the front to engage the applicator shaft and paddle shaft of the developing unit positioned at the development position. A solenoid **117** is actuable to move the drive unit toward the front in timed relation with the arrival of a developing unit at the development position. Before the developing unit is moved away from the development position, the solenoid is deactivated to permit the drive unit to move to the rear under the urging of a springs **119**. Thus, the apparatus has single drives and a motor which is engageable with each of the development units without the separate drives and expensive gear box shown in FIG. **2**. This is superior to the embodiment shown in FIG. **2** in weight, expense and in the noise produced. A third coupling approach would be to employ two solenoids, each engaging the two drive couplings separately or together, while the drive mechanism and motor remain stationary. This embodiment permits continual mixing of the developers in developing units when not developing and also provides the capability of removing developer from the applicator shell just before disengagement and indexing. The FIG. **2** embodiment is somewhat faster, not requiring the time needed for engaging and disengaging.

FIGS. **8–14** together with FIG. **4** illustrate the mounting of the photoconductive drum **2** in printer **1**. U.S. Pat. No. 5,138,372, issued Aug. 11, 1992 to DeCecca, is incorporated by reference herein. It shows the mounting of a photoconductive drum cartridge with respect to a transfer drum by use of an over-center spring which pushes the rear of the cartridge toward the transfer drum. Opposite ends of the shaft of the photoconductive drum extend outside of the cartridge and ride on a pair of upwardly angled surfaces that are fixed with respect to the transfer drum to assure that the axes of rotation of the two drums are maintained parallel when engaged. The cartridge is supported by a single additional support toward the rear of one side of the cartridge. Thus, the cartridge in this prior apparatus is supported by opposite ends of the shaft and this rear support providing the necessary positioning and support without being overconstrained. The precise vertical position of the photoconductive drum is not determined.

However, it is critical that the photoconductive drum not only be mounted accurately with respect to the development stations and the transfer drum, but also with respect to an exposing device, for example, the laser **5**. To accomplish this, as seen in FIG. **14**, the laser **5** is mounted in a laser housing **120** which, in turn, is mounted in a laser chassis **122**. On opposite sides of laser chassis **122** are a pair of rollers **124** which engage the top of a guide plate **130** and a pair of rollers **126** which engage the bottom of the guide plate **130** when the laser chassis is in the retracted position shown in FIG. **14**. The chassis is also connected to the mechanism plates of the apparatus through an over-center spring mechanism **128** which is shown in FIG. **14** with the laser chassis in its retracted position and in FIGS. **8–13** in its operative, extended position.

Also as shown in FIGS. **10** and **14**, laser chassis **122** has a photoconductive drum cartridge nest **134**. As best illustrated in FIG. **10**, nest **134** receives a photoconductive drum cartridge **140** as the cartridge is slid from front to rear in a direction generally parallel to the axis of rotation of photoconductive drum **2**. The cartridge is removable by grasping a handle **136** and moving it from rear to front. Insertion of the cartridge is done with the laser chassis **122** in the retracted position shown in FIG. **14**. Photoconductive drum cartridge **140** includes a housing **138** which is shown in section in FIG. **15** and which protects the photoconductive drum **2**. Housing **138** also defines an opening **144** (FIG. **10**) which receives an electrometer **142** when the cartridge is fully inserted in chassis **122**. The electrometer **142** fits in opening **144** to be positioned precisely with respect to photoconductive drum **2**. Electrometer **142** is connected to a process control circuit **148** to assist in the controlling of the electrophotographic process of the printer **1**. Process control circuit **148** is shown more specifically in FIG. **16** and will be discussed later.

Cartridge housing **138** also defines an opening **146** through which photoconductive drum **2** engages transfer drum **10** and an opening **152** (see FIG. **12**) through which the photoconductive drum **2** is engaged by the developments units, described above. An opening **150** is elongated back toward the laser **5** and is positioned for exposure of the photoconductive drum **2** by the laser **5**. Both of openings **146** and **152** can be closed by covers when the cartridge is outside of chassis **122** to protect the image surface **3**. The covers can be openable by suitable cams or lugs, not shown, as part of the inserting process.

Insertion of photoconductive drum cartridge **140** into laser chassis **122** is guided by a pair of rails **123** and **125** which fit in grooves **127** and **129**, respectively, as shown in FIGS. **12** and **15**. The rails and grooves guide the insertion of the cartridge accurately enough to assure that electrometer **142** enters electrometer opening **144**. As seen in FIG. **10**, as the cartridge is finally seated in chassis **122**, front and rear left pins **162** and **164** and a right pin **166** on the laser chassis enter seating holes **163**, **165** and **167** in the cartridge **140**. The pins **162**, **164** and **166** are bullet shaped to assure entry despite some looseness between the grooves and rails. Pins **162** and **164** are sized to snugly fit into openings **163** and **165** to firmly position cartridge **140** with respect to laser chassis **122**. Opening **167** is somewhat larger horizontally than pin **166** to allow the final positioning of the cartridge to be controlled with respect to transfer drum **10**, as will be described. An overridable latch (not shown) on the top of nest **134** engages a catch pin **168** to hold the cartridge in the chassis **122**.

The photoconductive drum cartridge **140** is inserted in the chassis **122** with the chassis in the retracted position shown in FIG. **14**. Once the cartridge is fully inserted and positioned with respect to laser housing **120**, a handle **156** on over-center spring mechanism **128** is moved from the vertical position shown in FIG. **14** to a horizontal position shown, for example, in FIG. **13**. Over-center spring mechanism **128** moves laser chassis **122** to the left thereby moving photoconductive drum **2** also to the left. As seen in FIGS. **4** and **8**, the ends of photoconductive drum shaft **7** ride onto first and second positioning surfaces **95** and **97** of first and second positioning members **83** and **85**, respectively. The shaft **7** rides on the positioning surfaces **95** and **97** until the photoconductive drum engages transfer drum **10**, as shown in FIG. **4**. At this position, the photoconductive drum **2** is controlled by the ends of shaft **7** resting on the first and second positioning surfaces **95** and **97** and the engagement with transfer drum **10**. It is also supported by rollers **124** resting on guide plate **130**. Engagement with transfer drum **10** is in the upper left hand portion of

photoconductive drum 2, which engagement urges transfer drum 2 with a force that has a vector in the downward direction which maintains contact between photoconductive drum shaft 7 and the positioning surfaces 95 and 97.

Thus, the structure has first accurately mounted the photoconductive drum cartridge 140 with respect to laser 5 and then moved both the laser and the cartridge together to a position controlled by the photoconductive drum shaft to assure proper relationship with the transfer drum 10 and the development device 6.

FIG. 15 shows a cross-section of photoconductive drum cartridge 140 which illustrates, in addition to the elements previously discussed, the photoconductive drum cleaning device 12. Photoconductive drum cleaning device 12 includes a blade 13 which scrapes toner off the image surface 3. Entrance to the cleaning device is protected by a roller 14 which prevents the escape of toner that is cleaned by blade 3. Rotation of roller 14 and drum 2 tend to move toner cleaned by blade 3 to the right, as seen in FIG. 15, and down into a cleaned toner sump 9 positioned both over and around the opening 150 for the laser 5.

FIGS. 17 and 18 show an easily assembled cleaning component 170 including roller 14 and blade 13. Two end pieces 172 define bearings for roller 14 and are fixed to a support 174. Blade 13 is fixed to the underside of support 174. Component 170 is readily fixed to housing 138 by fasteners shown in FIG. 15. The cartridge housing is closely spaced around roller 14 by end pieces 172 preventing buildup of toner on the roller and escape of toner upstream but does not inhibit rolling by directly touching the roller itself.

FIG. 16 shows a process control circuit 148 of a type generally well known in the art. More specifically, the process control circuit 148 receives inputs from a relative humidity sensor 160 and from an electrometer 142 and uses these inputs to control the charge deposited on image surface 3 by charging station 4, for example, by controlling a grid at charging station 4. The same inputs can be used to control the bias applied to applicator shell 61. The same inputs can be used further to control a laser control circuit 158 which controls the pixel-by-pixel intensity of laser 5.

A key to accurate process control, of course, is the inputs received. Electrometers are generally well known for use in process control, but have not heretofore been used with cartridge loaded photoconductive drums. The structure shown in FIGS. 10 and 14 for positioning the electrometer 142 with respect to image surface 3 makes process control usable in a cartridge loaded printer.

Carriage 31 also carries a bias source 76 for the applicator shells 61. Power for the carriage 31 is supplied by a flexible power cable 78.

FIG. 2 shows toner containers (herein sometimes called "bottles") 110, 111, 112 and 113 positioned on top of replenishers 63. These toner containers are positioned on the apparatus by a relatively untrained operator and opened. When opened, toner falls from the toner containers into a replenisher sump 180 (FIG. 3) forming part of the replenisher 63. Since the replenisher sump will not contain more than a small portion of the toner in the container, the container remains on the sump as part of the replenishing mechanism. The sumps themselves are shown in FIG. 3 minus a receiving structure for the containers that is shown, in part, in FIG. 2.

The containers or bottles and the receiving structure are more completely shown in FIGS. 19–25. Referring to FIG. 22, the bottle 113 includes a containing portion 186, a base 188, a cover 190, and a handle 192. The containing portion 186 and the base 188 are secured together or integrally formed to define an opening 194 through which toner can pass.

Cover 190 is secured across opening 194. It is made of a material, for example 0.010 inches thick polyester, which has appropriate stiffness and flexibility for this design, as will be explained. The cover 190 is supported for sliding movement by guide means which is partly defined by a curved guide surface 198. The handle 192 is fixed to cover 190 and protrudes through and is movable within a slot 200 in a vertical extension 207 of base 188. A compliant pad 202 is positioned in a slot 196 above cover 190 and extends slightly into the path of the cover to help prevent escape of toner from around the cover 190.

In operation, cover 190 is in its covering position, shown in FIG. 22, extending entirely across opening 194 underneath pad 202. Cover 190 extends around curved guide surface 198 to a vertical position adjacent a vertical exterior wall 204 of container portion 186 where it is attached to handle 192. When the operator raises handle 192, cover 190 slides around curved guide surface 198 to a position totally uncovering opening 194 at which position handle 192 is at the top of slot 200. The cover 190 is stiff enough that when handle 192 is returned to its lowered position, cover 190 is pushed in slot 196 back across opening 194 to its covering position though resisted somewhat by pad 202. Thus, the bottle has a removable and replaceable cover, which cover is stored in a position that does not protrude from the bottle. The cover itself is extremely thin compared to prior stiff covers. As such, it does not move toner substantially as it is returned into position but rather slices through any toner to its covering position. This allows the container to be removed with toner still in it, if desired. Though stiff enough for return movement, it is flexible enough to traverse a curved path to a convenient vertical position along wall 204.

The base 188 also includes structure for interfacing with a locking mechanism on the receiving apparatus. As seen in FIGS. 21 and 22, base 188 includes a groove 206 extending across the lower part of the front of base 188. Groove 206 defines a rib 208 at the bottom of the front of base 188. The rear of the base 188 has a rib 210 at the bottom facing in the opposite direction of rib 208.

The receiving apparatus is shown in FIGS. 20, 22, 24 and 25. According to FIG. 20, each receiving structure includes box-shaped upward extending vertical walls 182 which surround an opening 184 into the sump 180 (FIG. 3). A lever 212 is mounted for rotation about a axle 214. As shown best in FIG. 24, toner container 111 is inserted in the apparatus by first placing groove 206 around axle 214. Container 111 is then pushed backward, pivoting around axle 214 until it is positioned upright on the receiving structure. In this position, downwardly extending vertical, box-shaped walls 220 on the inside of base 188 fit over upwardly extending, box-shaped vertical walls 182 on the receiving structure and rib 210 at the rear of base 188 is seated on a surface 222 surrounding the upwardly extending walls 182. The mating box-shaped walls provide a tight enclosure preventing escape of toner.

In this position, the bottle is still closed and the handle 192 is in its lowered position. The lever 212 is ro-

tated about axle **214** to a vertically upright position. A slot **216** in lever **212** has a wide portion **217** and a narrow portion **218**. The wide portion fits around the handle **192** when the lever **212** is moved to its vertical position. A protruding detent **219** (FIGS. **24** and **25**) enters a recessed detent **221** (FIG. **21**) to hold the lever in its vertical position.

Rotation of lever **212** to its vertical position rotates a cam surface **226** formed integrally with lever **212**. A cam follower **228** moves to the left in cam surface **226**, as seen in FIGS. **19** and **22**. Cam follower **228** is attached to a locking detent **230** which is pulled over rib **210** to lock base **188** in position on the receiving apparatus.

As handle **192** is moved in an upward direction to open cover **190**, it slides out of the wide portion **217** of slot **216** and into the narrow portion **218** to lock lever **212** in its vertical position. At this point, the cover is in its uncovering position and toner falls through opening **194** in the toner container and further through opening **184** into the sump. While the cover is open, the lever **212** is held by handle **192** in its vertical position, maintaining lock detent **230** in position holding base **188** on the receiving apparatus.

Removal of the container is the reverse of the above procedure. The handle **192** is moved to its lower position moving cover **190** to its covering position over opening **194**. The lever **212** now can be moved to a horizontal position releasing lock detent **230** and allowing removal of the container. A finger hole **232** (FIG. **24**) allows easy removal.

The cover **190** and the pad **202** provide an adequate enough seal that the usual adhesive paper seal, conventionally used for such toner containers, is not necessary. However, because of this, it is important that the handle **192** not be raised when the container is not on a sump. Accordingly, a releasable latch (not shown) preventing opening of cover **190** is preferably formed in vertical extension **207** or extending from wall **204**. The latch is releasable by a protrusion (not shown) on lever **212** when lever **212** is raised to its vertical position.

Thus, this structure provides a container which is secured firmly to the receiving apparatus while having a tight interface between upward extending box-like walls **182** and downward extending boxlike walls **220** to prevent the escape of toner. A cover is movable between covering and uncovering positions without protruding from the container where it can prevent closing of the door or the like. Further, moving the cover to its uncovering position secures the locking device on the base so that it cannot be unlocked without closing the cover.

FIGS. **21–23** illustrate one approach for assembling container **113**. Referring first to FIG. **22**, the containing portion **186** can be formed in two parts including a primary containing piece **187** and a covering piece **189** which are heat or vibration welded together to form the containing portion **186**. At the bottom of the containing portion **186** around opening **194** is the upper part of slot **196** (see also FIG. **23**) into which is placed pad **202**. Vertical extension **207** with slot **200** and curved guide **198**, as well as ribs **208** and **210**, are all defined by a bottom piece **191**. Handle **192** is inserted in slot **200** in bottom piece **191** with cover **190** resting on an upper surface **193** of bottom piece **191**. Upper surface **193** forms the bottom of slot **196** and guide surface **198**.

A pair of protrusions **201** on containing portion **186** snap (or clearance) fit into holes **203** in bottom piece **191**. The rear of surface **193** also snap fits into the rear of the bottom of containing portion **186** using conventional snap fitting structure with interlocking step features (not shown). After the snap fit, either or both of the connections can be heat welded, if necessary. Thus, the guide means for cover **190** is formed, in part, by surface **193** on bottom piece **191** and, in part, by a complimentary surface **195** (FIG. **23**) of containing portion **186** and, in part, by pad **202** in slot **196**.

The container **113** is shown in FIG. **22** with a slanted guide means for cover **190** in its covering position. This is designed in this manner for convenience in manufacture. The portion of cover **190** covering opening **194** could be totally horizontal or tilted in a direction opposite that shown in FIG. **22**. A thin flexible polyester or similar material can easily traverse a curved path through a 90° or greater arc. The upwardly extending walls **182** are shown in FIG. **25** with a slanted top to mate with the receiving walls **220** and the slanted cover **190** shown in FIG. **22**. However, the walls **182** could have a horizontal top as shown in FIG. **20** with either the container shown in FIG. **22** or a container with a cover that has a horizontal covering position.

The invention has been described in detail with particular reference to a preferred embodiment thereof, but it will be understood that variations and modifications can be effected within the spirit and scope of the invention as described hereinabove and as defined in the appended claims.

We claim:

1. Image forming apparatus usable with a photoconductive drum cartridge having a photoconductive drum with a cylindrical photoconductive surface rotatable about an axis of rotation, said image forming apparatus comprising:

a laser,

a laser chassis for supporting said laser, said laser chassis including means for receiving such a photoconductive drum cartridge by movement of the cartridge parallel to the axis of rotation,

process control circuitry including an electrometer and means for controlling said image forming apparatus in response to a signal from said electrometer, and

means for mounting said electrometer fixed to said laser chassis and to be closely spaced from the photoconductive surface of a photoconductive drum of a cartridge received in said receiving means.

2. Image forming apparatus according to claim **1** wherein said process control circuitry includes means for controlling the level of charge applied to said photoconductive surface by a charging means.

3. Image forming apparatus according to claim **1** wherein said laser chassis is movable to position a photoconductive drum in a received cartridge with respect to other stations in the image forming apparatus.

4. Image forming apparatus according to claim **1** wherein said electrometer is positioned to enter an opening in a received cartridge as the cartridge is moved into the receiving means.

5. Image forming apparatus according to claim **4** wherein said receiving means includes means defining a nest for a received cartridge which nest includes a wall generally traverse to the axis of rotation of a received cartridge drum, said electrometer being mounted to said wall and extending into the nest in a direction parallel to the axis of rotation.

6. A photoconductive drum cartridge including a housing, a photoconductive drum having a cylindrical photoconductive surface rotatable about an axis of rotation, a housing for protecting said surface, said housing including an endwall transverse to said axis of rotation, and an opening in said endwall for receiving an electrometer closely spaced from said cylindrical photoconductive surface.

7. A photoconductive drum cartridge comprising:

a photoconductive drum having a cylindrical photoconductive surface and an axis of rotation, means for cleaning toner off the photoconductive drum, said cleaning means including a blade engaging the photoconductive drum to scrape toner off the drum and a roller positioned upstream of the blade and rollable by the photoconductive drum to move cleaned toner toward the blade, and

a housing including means for supporting said photoconductive drum for rotation about the axis of rotation, said cartridge being insertable in an image forming apparatus by movement generally parallel to the axis of rotation and having a leading end during such movement, said housing including a wall at said leading end positioned transverse to the axis of rotation of the photoconductive drum, and an opening in said wall for receiving an electrometer when said photoconductive cartridge is positioned in an image forming apparatus.

8. A photoconductive drum cartridge according to claim 7 wherein in operation said blade is positioned vertically below the roller and the cartridge includes a toner containing means on the opposite side of the blade from the roller for receiving and containing cleaned toner.

9. A photoconductive drum cartridge according to claim 7 further including a unitary support for the blade and the roller.

10. A photoconductive drum cartridge comprising:

a photoconductive drum having a cylindrical photoconductive surface,

a housing protecting said drum, and

a cleaning means supported by said housing and including,

a blade engaging said drum to scrape toner from the photoconductive surface,

a sealing roller positioned upstream from said blade and vertically above said blade and engaging the drum to prevent escape of toner, and move toner cleaned by said blade back toward the blade, and

a collection means for collecting cleaned toner, positioned on a side of the blade opposite the roller.

11. Image forming apparatus usable with a photoconductive drum cartridge having a photoconductive drum with a cylindrical photoconductive surface rotatable about an axis of rotation and a housing protecting the photoconductive drum which housing includes a cartridge endwall transverse to the axis of rotation, said cartridge endwall having a hole, said image forming apparatus comprising:

means for receiving such a photoconductive drum cartridge by movement of the cartridge parallel to the axis of rotation with said cartridge endwall leading in such movement, said receiving means including a nest for said cartridge including a nest endwall generally parallel to the cartridge endwall of a received cartridge,

process control circuitry including an electrometer and means for controlling said image forming apparatus in response to a signal from said electrometer, and

means for mounting said electrometer on said nest endwall to enter the hole in the cartridge endwall during movement of the cartridge into the nest to closely space the electrometer from the photoconductive surface of a photoconductive drum of a received cartridge.

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